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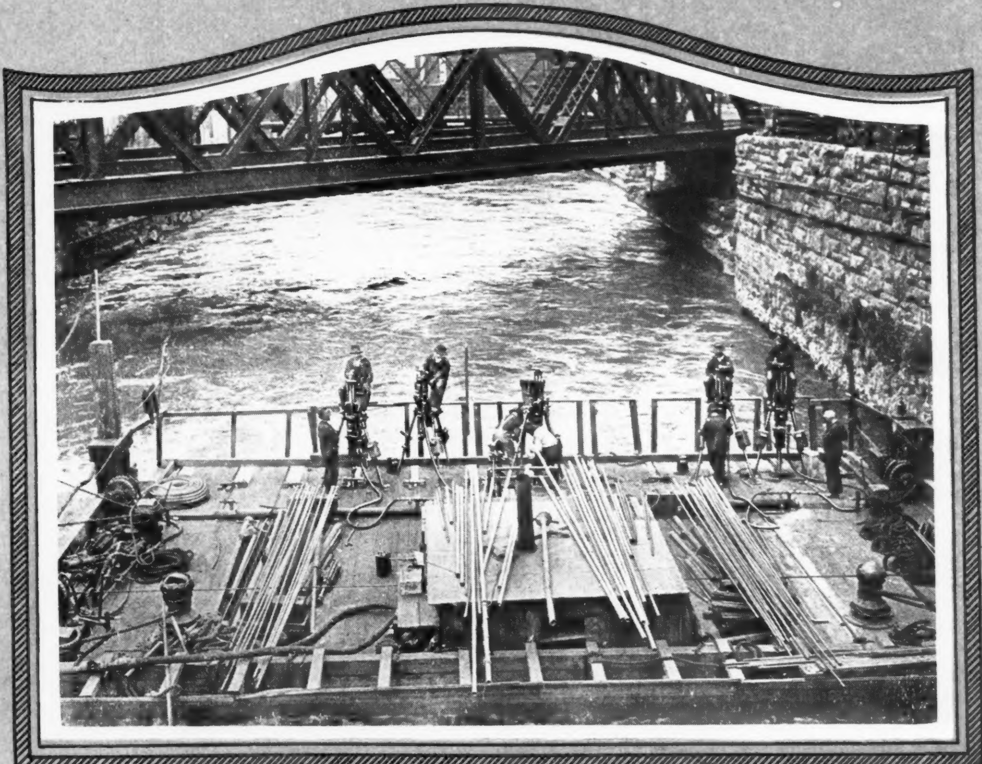

A BATTERY OF FIVE COMPRESSED AIR DRILLS BORING HOLES FOR BLASTING OUT THE BOTTOM OF THE NIAGARA FALLS POWER CANAL.

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The Use of Scrapers in Metal Mines

Important Recent Development in Ore Extraction, a Decided Factor in Reduction of Operating Expense—Compressed Air Provides Safe and Convenient Form of Power

By LUCIEN EATON

DURING THE LAST five years, a period of rapidly rising wages and scarcity of labor, incident to the financing and prosecution of the World War, one of the most vexing problems confronting the operators of mines has been the reduction of the cost of loading ore underground. The tremendous advances made in the design and construction of rock-drills and the improvements in drilling methods have helped to keep down the cost of breaking ore, but comparatively little has been accomplished in the way of cheapening the cost of shovelling.

Nearly every mine operator and manufacturer of mining machinery has had his own ideas about shovelling machines, and a great many designs have been made and tried. A description of the most important of these machines was given by Mr. A. M. Gow in the *Engineering* and *Mining Journal,* Vol. 109, No. 5, p. 319. A number of these machines have attained a reasonable degree of reliability and have been fairly successful in drifts and in large stopes. There is no question but that further improvements will be made in these machines and their scope considerably enlarged, but at present their applicability has been found to be rather limited.

One of the more recent developments in the loading of ore underground has been the drag-scraper or "slusher." This has found such favor that there is hardly a mining district where experiments are not being made and scrapers of various types being tried. There has been very little written on this subject, and the consequence is that there must be a vast amount of labor and thought wasted in duplication of experiments. There has been a limited interchange of ideas privately, but what is needed is a general discussion, wherein each experimenter can air his views and give his results, and find out what the other fellow is doing. It is with the idea of starting such a discussion that I have presumed to write this article. My own experiments have been so promising that I am convinced of the ultimate success of this type of loader, but they have not gone far enough to determine the limits of its application. In fact the farther I have gone the greater seems to be its field.

In its simplest form the "scraper," "drag-loader" or "slusher," as it is variously called, consists of an ordinary horse-scraper, such as is used in moving earth short distances on surface. This is pulled to a chute by a small hoist, and is dumped and pulled back by hand. From this there have been many variations both in size and shape until we have scrapers weighing many hundred pounds, dumped automatically and pulled both ways by powerful engines. Nearly every mine has peculiar conditions to be met, and these varying conditions, as well as the variations in the weight and size of the pieces of broken ore have led to the many different designs of scrapers that have been tried.

In general, scrapers can be divided into two classes:

I. Those in which the material is carried in or on the scraper, and

II. Those in which the material is dragged along the floor of the drift or stope in front of the scraper, as dirt is moved with a hoe. Scrapers of the second class can be further sub-divided as follows:

A. Those without sides.

B. Those with sides.

Furthermore they can be equipped with teeth or can have a plain digging edge. Illustrations of the different types are given below.

One of the most successful examples of the use of scrapers of the first class underground, a description of which is given in Mr. Gow's article, above referred to, is at the Spruce and Adams Mines of the Oliver Iron Mining Co. at Eveleth, Minn. Here small "slushers," only slightly changed from the ordinary surface type, have been used both for putting ore in the chute and for loading cars. The design of this "slusher" is shown in Fig. 1. The "slusher" is hauled to the chute or car by a small Ingersoll-Rand "Little Tugger" hoist, developing about two and one-half horsepower and is dumped by hand. It is dragged back to the ore-pile by hand and filled in the usual way. The work is done by the miners, one running the hoist and the other handling the "slusher." As handling the "slusher" is hard work the men change off at frequent intervals, and so avoid excessive fatigue. Excellent results have been obtained, the tons per miner per shift having been increased over 23 per cent.

In this case the "slusher" holds three cubic feet and usually pushes another two cubic feet in front of it. The hoist can develop a pull of 800 to 1,000 pounds and has a speed of 80 to 90 feet per minute. The rate of loading is ten to fourteen tons an hour for short periods and the effective limit is about 50 feet from the chute.

The same "slusher" is used for loading directly into cars by being dragged up an incline made of boards, but it is a slower process.

The advantages of this system are its simplicity and low cost. After the blast no time is lost in rigging up, and, when the bulk of the broken ore has been moved, the edges of the pile and ore scattered in other parts of the stope are easily cleaned up. The disadvantages are that the physical labor entailed is hard and only men of strong physique are able to make a success of it. Furthermore the loading speed and the effective radius are not large.

In order to reduce the labor requirements a snatch-block can be put in the breast and a tail-rope run through it to pull the scraper back. This also makes possible the use of a larger scraper, thereby increasing the load per trip and the rate of loading per hour, but there is some delay in getting started, and the larger scraper is not so handy for cleaning

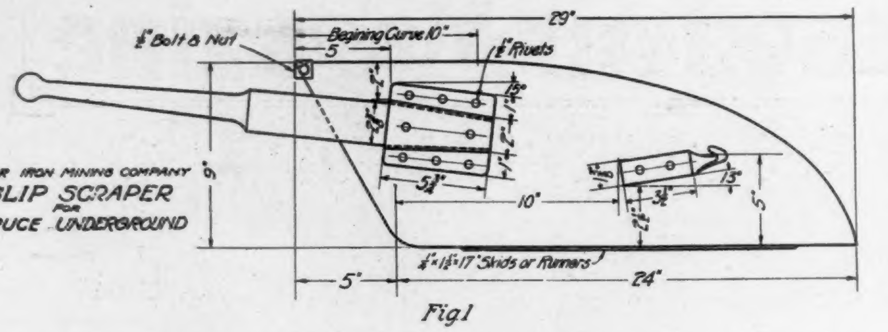


Fig 1

up. It is still necessary to dump the scraper by hand, and a larger hoist with a double-drum is required. There is a difference of opinion as to the advantages and disadvantages of the tail-rope, some maintaining that the increased first cost, delay in starting and cleaning up, and decreased flexibility outweigh the saving in labor and the higher loading-speed per hour. Under some conditions this is undoubtedly true, but if the scraper could be made to dump automatically so that it would be unnecessary for one man to walk back and forth between the ore-pile and the chute the advantage of the tail-rope would be immensely increased.

Various types of scrapers that dump automatically have been built to meet the requirements of different kinds of work. They have nearly all been of the bottomless type, but the designs have been widely divergent.

One of the most successful scrapers for surface-work has been the Bagley scraper, which has been largely used in the West in stripping and excavation. It is not suitable for underground use. More recently the T. L. Smith Co. of Milwaukee has developed a scraper-loader for handling gravel. This uses a large scraper with a bottom, which is hauled up a short incline, and dumped by an ingenious mechanism which raises the scraper bodily. It is not suitable for underground work on account of the head-room required.

The Goodman Manufacturing Co. of Chicago makes a loading-outfit for use underground in coal-mines, in which a bottomless scraper is used. It is said to be successful in loading coal, but is not suitable in its present form for use in metal mines. It has been described by Mr. Gow.

Probably the earliest development of the drag-scraper underground in metal mines was in the Joplin lead and zinc district and in the Platteville district in south-western Wisconsin. The design of one of the types of scraper used by the Vinegar Hill Zinc Co. is shown in Fig. 4. A typical Joplin outfit is shown in Fig. 5. The larger scraper weighs 680 pounds and requires 10-15 horse-power to operate it. The snatch-block for the tail-rope is hung on a wire rope stretched across the stope, and is moved from side to side as the loading progresses.

The hoist is mounted on a turn-table so that the fleet-angle of the ropes on the drums is never excessive. The best results are obtained with this scraper, when delivering to a chute. In Fig. 6 the same scraper is shown in the position in which it is dragged back to the breast. It will be noted that the back-bail is attached near the top of the blade, so that the scraper is quickly turned upon its back.

In the Lake Superior copper mines scrapers have been used for several years. A modification of the Bagley scraper was developed by the Quincy Mining Co. in 1915, and has been used to a certain extent by the Calumet & Hecla Mining Co. and the Mohawk & Wolverine Mining Companies. The design is shown in Fig. 7. It is a bottomless scraper, having two digging edges, one with teeth and the other without. The teeth are used to scrape out the large chunks and then the smooth edge is used to move the fine dirt. This scraper has been very successful in pulling broken ore down the foot-wall, which dips at about 30 degrees, but gives poor results on the level. Double-drum, double-cylinder 5"x6" engines driven by air furnish the motive power. Needless to say a tail-rope is used.

The Calumet & Hecla Mining Co. has developed another type of scraper which came originally from the Joplin District, and has been very successful in using it not only to pull broken ore down the foot-wall, but also to pull both ore and waste along the level floor of drifts and stopes, and up an incline into a car. This type of scraper is also used by the Quincy Mining Co. and is shown in Fig. 8. The method of operation is shown in Fig. 23. The motive power is supplied by a double-drum air-driven engine with six-inch by nine-inch cylinders, mounted on the loading platform at the top of the incline. The incline and platform are made of two-inch plank spiked to six-inch by six-inch timbers. The flat platform is made long enough to cover two cars, so that there will be less delay in switching. The scraper itself weighs approximately 400 pounds, and a 300-pound weight is added on the back to increase the digging-power. It can load 65 to 150 tons a shift into cars, and can handle chunks weighing as much as a ton. It is effective for distances in excess of 100 feet.

The development of scrapers for handling soft hematite has not been difficult. Starting with an ordinary three cubic foot scraper, I have experimented with several different designs with a fair amount of success. One of the most successful is that shown in Fig. 9. It is a bottomless scraper with sides, and weighs less than 200 pounds, but it will move fine ore at the rate of 30 tons an hour from 40 feet. When the distance is greater than 50 feet from the chute the rate of loading decreases rapidly. This scraper will not work in lumpy ore, and it has not been tried for loading directly into cars. Another design

Fig. 2. Little Tugger "Slusher" mucking ore into chute.

made for handling soft ore containing chunks is shown in Fig. 10. This has worked satisfactorily, but might well be made heavier.

The hard, specular hematites present a much more difficult problem than any of the ores for which the scrapers described above were designed. They have a very high specific gravity and break into large irregular pieces. For this reason it is very difficult to find a scraper that will dig into the broken ore, especially when the piles are large. Three designs are now being tried. One is that developed by the Vinegar Hill Zinc Co., shown in Fig. 4; one is a special design, using some old steam-shovel teeth that were on hand, and is shown in Fig. 11, and one is a double-faced scraper adapted from the Joplin design. This is shown in Fig. 12. The motive-power is supplied by a double-drum Lidgerwood hoist with six by eight inch cylinders, run by compressed air. Under favorable conditions the scraper shown in Fig. 11 has loaded ore into the chute at the rate of 100 tons an hour. The hoist is, however, hardly large enough for it.

In attacking this problem of handling ore with scrapers the first consideration has been to develop a scraper that will dig. When that has been accomplished, the size and type of hoist most suitable for the work must be found, and the best method of using the apparatus worked out.

In designing a scraper the first things to consider are the angle of the digging edge, and the point of application and the direction of the line of pull. In practice the hauling rope is approximately parallel to the face of the ore-pile or the floor of the drift or stope, and from three to eight inches above it. The bail should therefore be made to come to that height above the floor, when the scraper is in its normal position. It would seem that the maximum digging effect would be obtained when the plane of the cutting edge lies in the resultant of the pull of the rope and the weight of the scraper. For instance, if the scraper weighs 500 pounds and the rope-pull is 500 pounds, the resultant would make an angle of 45 degrees with the horizontal. In general the heavier the scraper in comparison with the pull of the rope the steeper the cutting edge should be. In practice, however, the rope-pull is not constant, increasing as the scraper takes its load, so that the most efficient digging angle can be only approximated. In all of the designs that I have seen it varies between fifteen degrees and 30 degrees, and is usually about twenty degrees.

Fig. 3. Little Tugger "Slusher" in operation.

Let us assume now a digging angle of twenty degrees and a horizontal pull applied four inches above the floor. It is easily seen that a blade made of a straight plate set at twenty degrees with the horizontal would extend back too far to be self-dumping, and would overbalance the bail as soon as it picked up any load. For this reason the plate is usually curved so that it acts both as a digging edge and as a back. Radii of twelve to twenty inches work out satisfactorily for the curve. Whether or not teeth should be used can be determined only by experiment. Usually they are not necessary.

The next thing to be decided is the size of the blade, which determines the capacity of the scraper. For underground work it must be a compromise between excessive weight and mobility. In my own experiments I set for myself as a goal temporarily a capacity of half a ton at a trip, and a round trip per minute from 50 feet. This capacity can be obtained by a blade 42 inches wide and sixteen to eighteen inches high. Whether or not sides should be added depends on the material to be handled. They do not work well in coarse material, as they tend to keep the blade from digging into the pile. If they are used, they take the place of part of the bail. In the scraper shown in Fig. 9, they act as part of the bail, and are held apart by a heavy strap across the top. The real bail is of chain, and can be attached at any one of five pairs of holes, as the character of the material requires. The second hole from the bottom has been found to work best.

If no sides are used the bail should be rigid and should be attached near each end of the plate and brought over the top, and the two sides brought together at a point about four inches higher than the digging edge of the blade and at least four feet in front of it. The bail should be heavy enough to overbalance the weight of the blade behind the cutting edge, and to hold itself down to its proper position. This will be clear, if Fig. 10 is referred to. The weight of the blade, and that part of the sides and of the bail that are behind a vertical plane passing through the cutting edge, acting on the cutting edge as a fulcrum, tend to lift the front end of the bail, and the bail must therefore be made heavy enough to overcome this tendency and to keep itself in its proper position.

There should be no top to a scraper, for, as soon as the ore strikes the top the scraper begins to ride over the pile and loses much of its load. This is especially true when handling coarse material, in which large chunks will often stick up between the sides of the bail and lock themselves between the bail and the blade.

It is obvious that a scraper must be heavy enough to force itself down into the broken ore quickly, and therefore that the coarser and heavier the pieces of ore, the heavier the scraper must be; but it should be no heavier than is absolutely necessary for digging. The requisite strength can be obtained with very light materials. When working in soft ore the man who is in the breast of the drift can,

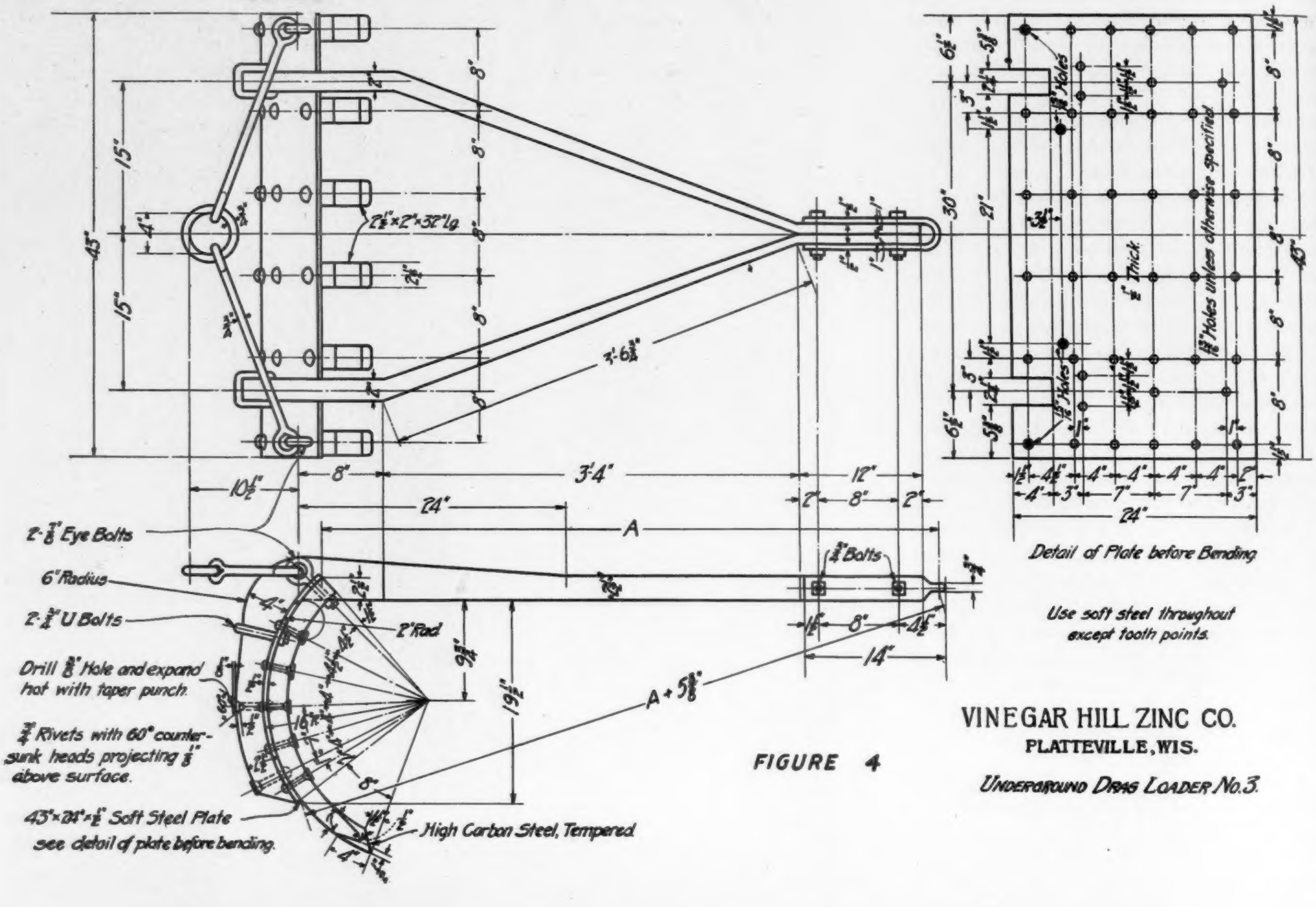


FIGURE 4

Fig. 5. Simple electric drive used in Joplin district.

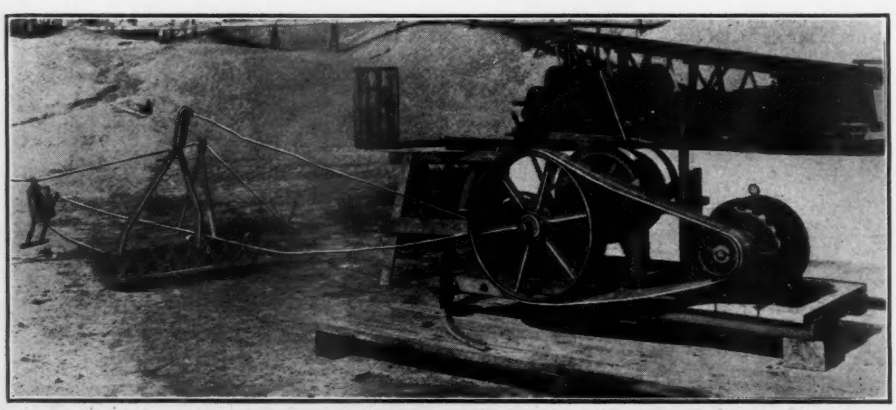


Fig. 6. Another position of scraper operated by electric drive in Joplin district.

if necessary, step on the scraper when it is taking its load and ride a few feet.

There is a diversity of opinion as to the size and type of hoist best suited for the work under discussion, and it is probable that more benefit will be derived from a general expression of opinion on this question than from any other part of the subject. Unquestionably hoists of several designs and sizes will be needed to meet all conditions, but there is an excellent opportunity for standardization in the different sizes.

Electricity and compressed air are the only sources of power suitable for underground

Fig. 5(a). Drag operated by little Tugger Hoist, Ohimo Mine, Bilharz Mining Co., Joplin, Mo.

work, and each has its advantages. In a dry mine with inadequate compressor capacity, with most of the work concentrated on main levels, and with electric haulage already in use or contemplated, electricity will give more economical results than compressed air; but under almost all other conditions, the convenience, simplicity and safety of compressed air give it, in my opinion, a decided advantage.

An example of a simple, effective electric drive is shown in Figs. 5 and 6, which is typical of Joplin practice. With any electric hoist provision must be made for slippage when the scraper gets caught on some obstruction, so that the motor will not burn out. In this case slippage is provided by the belt. In Fig. 13 we have another electric hoist, built by the Lake Shore Engine Works of Marquette, Mich. It is powerful and compact. The speed-reduction is made by a worm-gear, and slippage is provided in the clutch. It has a rope-pull of over 2000 pounds at a speed of 110 feet per minute, and weighs 1400 pounds. The motor can be easily removed, reducing the weight of the drums and frame to about 1000 pounds.

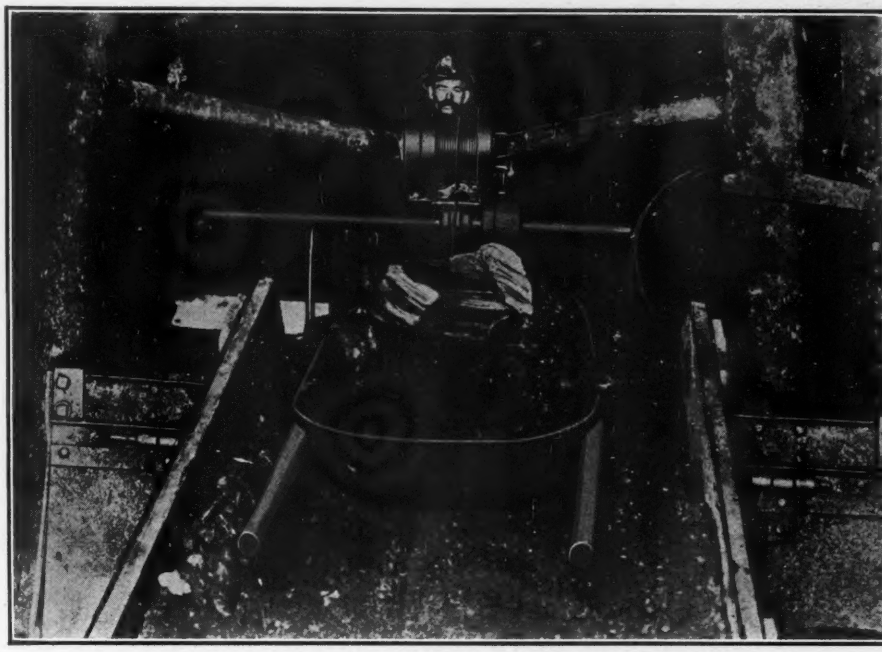


Fig. 6 (a). Little Tugger "Slusher" hauling ore up incline and dumping into tram car

Compressed air is almost the ideal means of transmitting power in small quantities underground. It is particularly suitable for operating small portable hoists. In the first place compressed air to operate the drills is in almost every working-place and it will be available without extra piping for pulling the scrapers, when the drills are not running. By the use of Dake engines air-driven hoists can be made very compact and powerful, with a minimum of weight and maximum of portability. A number of hoists of this type are on the market today with engines varying from two to six horse-power. All of the standard types have single drums, and are suitable for handling scrapers without a tail-rope. The Ingersoll-Rand Company is developing several new hoists especially designed

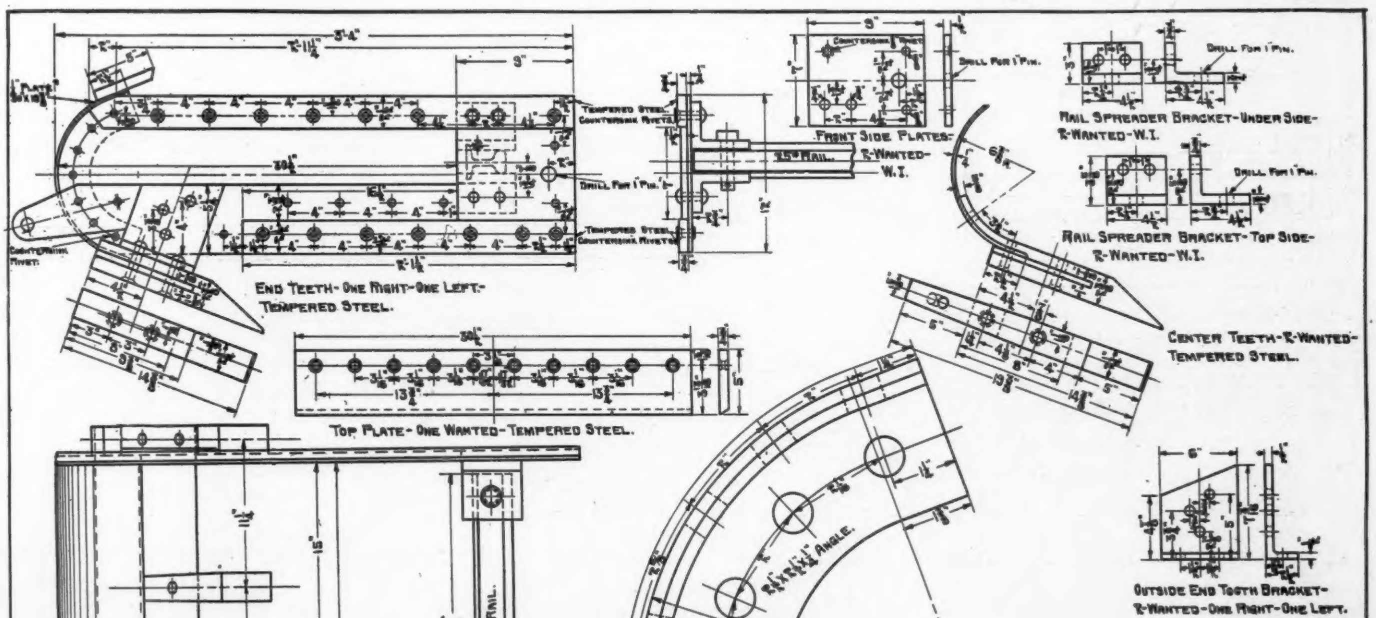


FIGURE 7

for handling scrapers, which promise to meet all the requirements of scrapers in soft, medium and hard ore.

For the larger scrapers more powerful engines are required. These are usually of the double-cylinder type, geared about 5 to 1 to double drums, which are loose on the shaft, and develop from 20 to 40 horse-power. The Lake Shore Engine Works at Marquette, Mich., have designed a hoist of this type especially for handling scrapers, but almost any double-drum erector's hoist can be adapted to this work.

For work on sub-levels in soft ore mines my specifications for a hoist would be as follows:

MOTIVE-POWER	compressed air.
HORSE-POWER	5 to 6 H. P.
WEIGHT	not more than 600 lbs.
SIZE	not more than 2 ft. x 2 ft. x 3 ft.
DRUMS	two, loose on shaft, with capacity for 200 ft., ⅝" rope each.
ROPE SPEED	150 ft. per minute at half load.
CLUTCH	jaw-clutches or gear-shift with single-lever control, either drum to engage with clutch, with neutral point where both drums run free.
MOUNTING	to be arranged for mounting on vertical drill-column or on swivel plate on skids.
ROPE-PULL	1500 to 1800 lbs. at 80 lbs. of air.
BRAKE	band-brake on at least one drum.

For the larger scrapers for coarse ore the engine should have much more power and less portability. It should be easily taken down and easily assembled, no piece weighing more than 600 lbs. It also should be compact and self contained, so that it can be moved in drifts or stopes without dismantling. In general the specifications should be as follows:

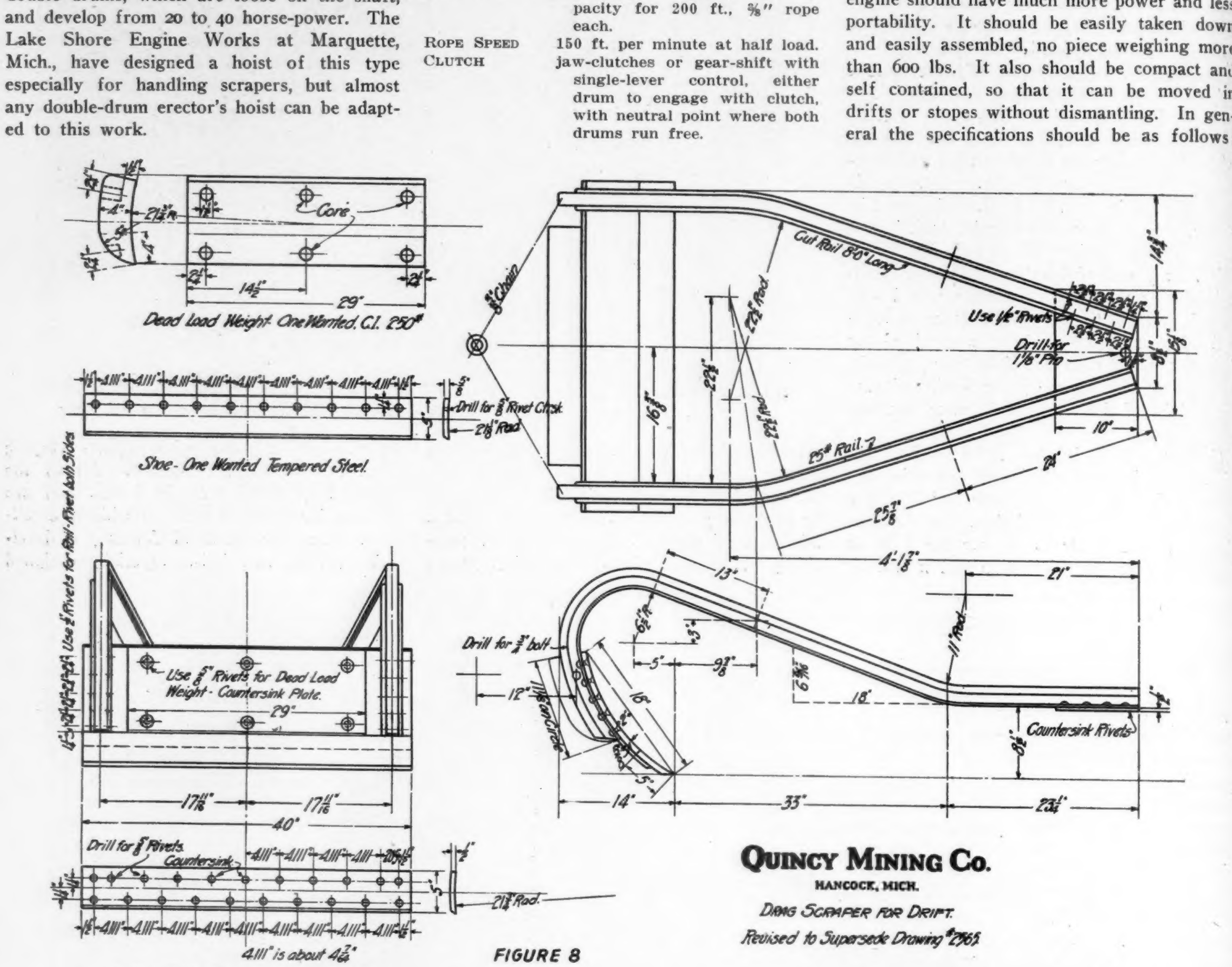
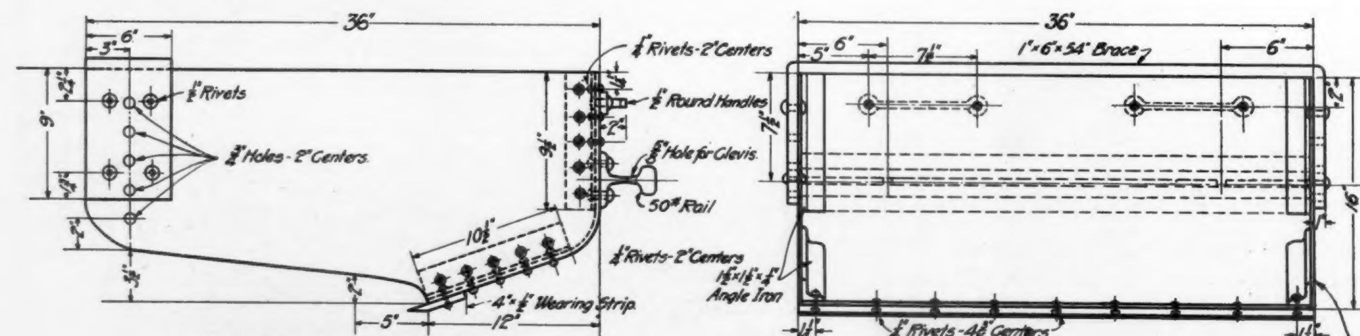


FIGURE 8

Splice Plate - One Wanted Steel Plate.



BILL OF MATERIAL			
Description	Size	Number	Remarks
Side Plates	¼"×16"×36"	2	Soft Steel
Back Plate	¼"×12½"×35½"	1	
Brace	1"×6"×56"	1	
Handles	¾"×15" Rd.	2	
Wearing Strip	½"×4"×36"	1	Hardened Steel
50# Rail	36" Lg.	1	Soft Steel
Angle Iron	1½"×1½"×¼"×9½"	2	
" "	1½"×1½"×¼"×10"	2	
Rivets	½"	16	
"	¾"	43	

FIGURE 9

SOFT-ORE-SCRAPER
CLEVELAND-CLIFFS-IRON-CO.
Mining Engineers Office. Ishpeming, Michigan.

MOTIVE-POWER	compressed air.
HORSE-POWER	15-35 H. P. (Depending on size of scraper).
WEIGHT	no piece more than 600 lbs.
SIZE	not more than 3½ x 3½ x 5'.
DRUMS	two, loose on shaft, each with capacity of 500 ft. ½" rope.
ROPE SPEED	200 feet per minute.
ROPE-PULL	3000 lbs. at 80 lbs. air.
CLUTCH	friction type, independent control for each drum.
BRAKE	band brake on one drum.
MOUNTING	base-plate arranged for mounting on skids.

This type of hoist might well be run by electricity in dry places where power can be easily taken off the trolley-wire. The motor should have excess power, so that the clutch will slip before the motor stalls.

In general it has been found that best results are obtained by scraping ore into a chute, rather than directly into a car. If possible the chute should be large enough to hold several cars of ore, so that there will be no delay from intermittent car-supply. In loading directly into cars considerable time is, of course, lost by either the loaders or the trammers or both, unless both operations are performed by the same crew. In that case the efficiency of the men is raised and that of the machines is lowered.

An example of scraping ore down along the foot-wall into chutes is shown in Fig. 16. The main drift is first driven in the vein and an overhand stope started. Stulls are then put in close together over the drift and chutes built at frequent intervals. For 30 or 40 feet above the stulls the ore is thrown far enough by the force of the blasts to run into the chutes by gravity, and no scraping is necessary. When the stope has progressed further the broken ore hangs up on the foot-wall and has to be scraped down. The hoist is set up in the drift about 50 feet to one side of the stope and snatch-blocks are hung opposite the mouths of two chutes. The tail-rope goes around one block up to the back of the stope, where it passes over two more snatch-blocks fastened to sprags opposite the chutes. The hauling rope is passed over the other snatch block and up through the chute. In operating a car is spotted under the second chute, the stoppers are taken out and the ore is pulled down the stope until the car is filled. The Quincy type of scraper has been most successful for this work, having an average load of nearly a ton per trip. Only one man is necessary for operating, and, if electric haulage is provided, he can do the tramming as well. Under these conditions one man often will load and tram 100 tons in a shift.

When the foot-wall is flatter the arrangement shown in Fig. 17 can be used. The drift is driven partly or wholly in the foot-wall, if necessary, and the engine is mounted on top of the drift timbers. The ore is scraped into two chutes, from which the cars are filled on the track below. Usually only one snatch block is used, and that one is hung on a wire-rope or chain stretched across the stope near the breast. This block is moved laterally as the loading of the ore requires. This arrangement is easily adaptable to a horizontal stope

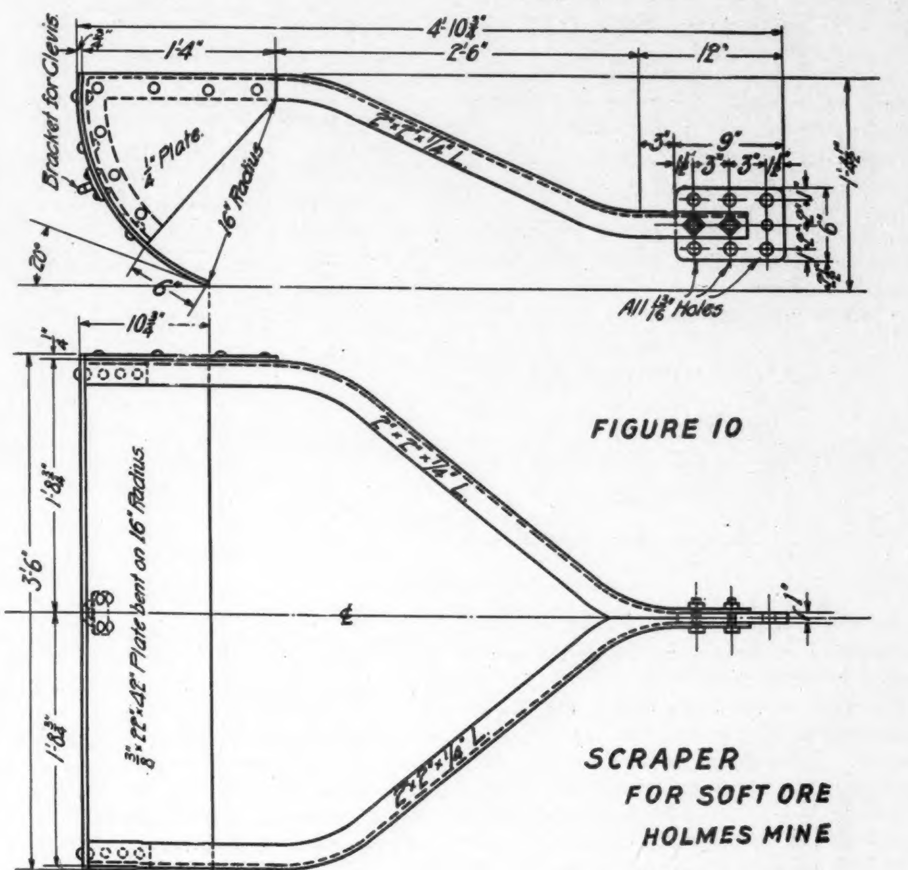


FIGURE 10

SCRAPER FOR SOFT ORE HOLMES MINE

SCRAPER FOR HARD ORE CLIFFS SHAFT MINE Wt. 872 lbs.

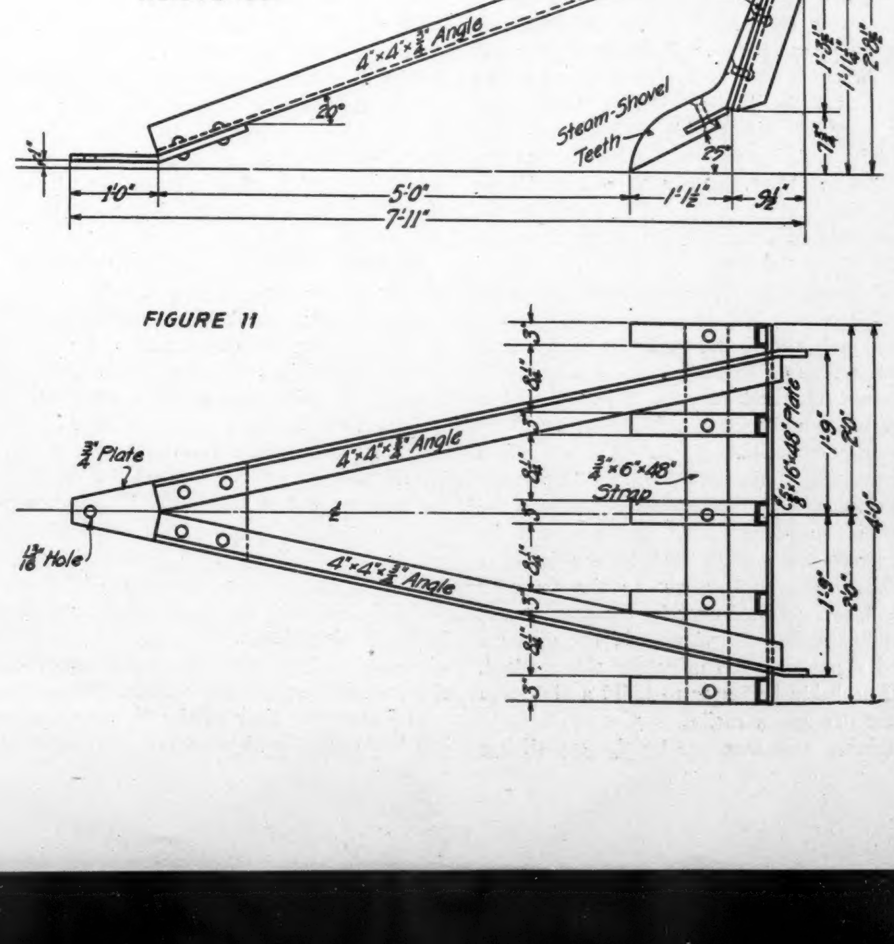
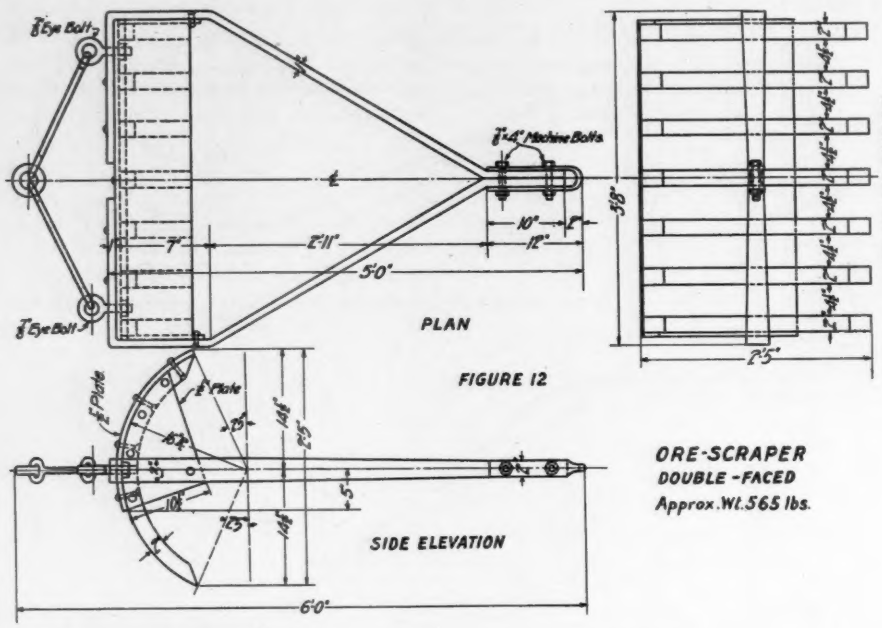


FIGURE 11



by building an incline, up which the ore is hauled to the pockets.

For work on sub-levels in soft ore the arrangement is slightly different, as shown in Fig. 18. The hoist is mounted usually on a four and one-half inch drill-column behind the chute and a snatch-block is hung on a three inch bar (drill-column) set up across the drift high up near the breast, or on the end of a pole spiked to the cap of the last set and extending to the breast. The loading is done by the miners, one of whom operates the hoist, while the other stays in the breast, picking down the sides as the ore is removed and moving the snatch-block or scraper, when necessary. Two men can clean out a blast of 40 to 50 tons in two and one-half to three hours.

The great problem in using scrapers on the sub-levels is side-slicing. The first drift is easily handled, because it is straight away from the chute and the broken ore is confined between narrow limits. Before taking another slice on either side, the side of the first drift must be closely lagged, so that the ore from the blast will not be scattered over both drifts, and great care must be taken not to knock down a set and get a run from the back.

It is possible to move ore with a scraper around a corner, but the operation is unsatisfactory and inefficient, especially if the turn is greater than 60 degrees. Two extra snatch-blocks are required for the tail-rope, and a curved plate must be provided to cover the leg at the turn, with planks on edge spiked along the side of the drift to guide the scraper to the turn. If the distance beyond the corner is short, much of the ore will be thrown into the straight drift by the force of the blast, and the rest can be thrown over by hand, or be pulled over by the scraper and then rehandled to the chute. If the distance beyond the turn is too great for this method, it will probably be better to build a slide and load the ore into a car.

In mining soft iron ore by the top-slicing and caving system it is customary to put up raises at about 50 foot intervals along the main drifts and to conduct stoping operations on the sub-levels by cross-cutting to foot and hanging, and then drifting both ways from the ends of the cross-cuts for about 25 feet. Side drifts are then driven along these drifts, until a sufficiently large stope has been opened. This is then blasted in, and the process is repeated, retreating towards the raise. In this method of mining in its present form scrapers cannot be successfully used. Some modifications are necessary. A number suggest themselves. For example, the cross-cut from the raise can be driven, using a scraper. When the limit has been reached, a drift is started at the end on one side, and after it has advanced two or three sets, a track is laid in the cross-cut and a slide is built at the end of the drift. The drift is then continued to the line of the next cross-cut, the ore being loaded into the car by the scraper. Successive side-drifts will then be driven in the same way. By this modification the entire pillar on one side of the cross-cut will be mined from that cross-cut, instead of part of the pillar on each side being mined. See Fig. 20.

Probably a better modification would be to put up the raises at 25-ft. intervals. The cross-cut on the sub-level could then be driven as usual, using the scraper, and in retreating one set could be taken out on each side, the broken ore being nearly all thrown out into the cross-cut by the blast. See Fig. 21. Another scheme would be to put in a small branch chute on each side of the raise near the top, so that a slice could be taken advancing on either side of the original cross-cut, the ore being pulled directly into these branch chutes. These chutes could be small, probably not over two feet square, and could be lined with planks. See Fig. 22. In either of these methods the slice mined from each chute would be three sets wide.

The economic limit of the distance that ore can be handled with scrapers is variable depending on the cost of loading by hand and the efficiency of the scraper used. In general it may be put at 75 feet for the kind of work just described and best results are obtained at 50 feet or less.

In loading ore into cars in a drift a slide is built of plank with a slope of about one in three. This should be flared at the bottom to permit radial movement of the scraper, and should have sides about six inches high. The upper end should be higher than the top of the car. In some places no platform beyond the slide is used, but, if the volume of material to be handled is large, a platform is an advantage. The platform is built high enough for a car to go under it, and a hole is left in it of proper size for filling the car. The hoist is mounted on the platform, and the snatch-block is hung in the breast from a bar, rope or sprag. The broken ore is pulled up the slide and falls through the hole in the platform into the car.

Sometimes the slide is built long enough to accommodate two cars, thereby saving time in switching. This has an added advantage in giving room for the storage of part of a car-load of ore on the platform while the cars are being switched. Three heavy rails laid lengthways in the drift will facilitate the movement of the scraper. Bottomless scrapers without sides are the best for this sort of work. This method of loading is illustrated in Fig. 23. As much as 150 tons have been loaded in one shift in this way, and the economic limit of haul is about 125 feet. When the breast has advanced 100 feet the platform should be moved ahead and set up again 25 feet from the breast. The first use of scrapers in this way was, I think, by Capt. G. A. Anderson on the Cuyuna Range, but no tail-rope was used.

In starting the use of scrapers underground the co-operation of the workmen is essential. Unforeseen difficulties will arise and the usual opposition to any innovation is likely to develop on the part of some of the men. If, by using the same amount of physical exertion, a man can increase his output 25% with a scraper, it is obvious that, in order to secure his coöperation, he must receive some return for a part of this increase. Otherwise he will see no object in changing from labor to which he is accustomed to a new kind of work to which he will have to adapt himself. If, on the other hand, his work is made easier he will be in favor of the change right from the start.

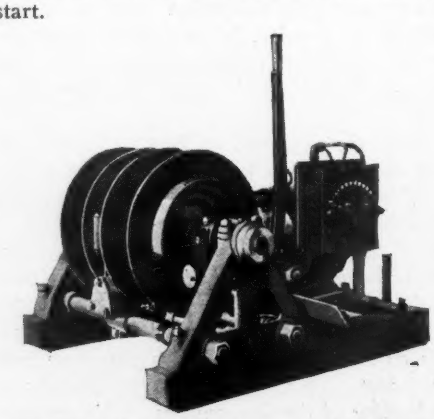
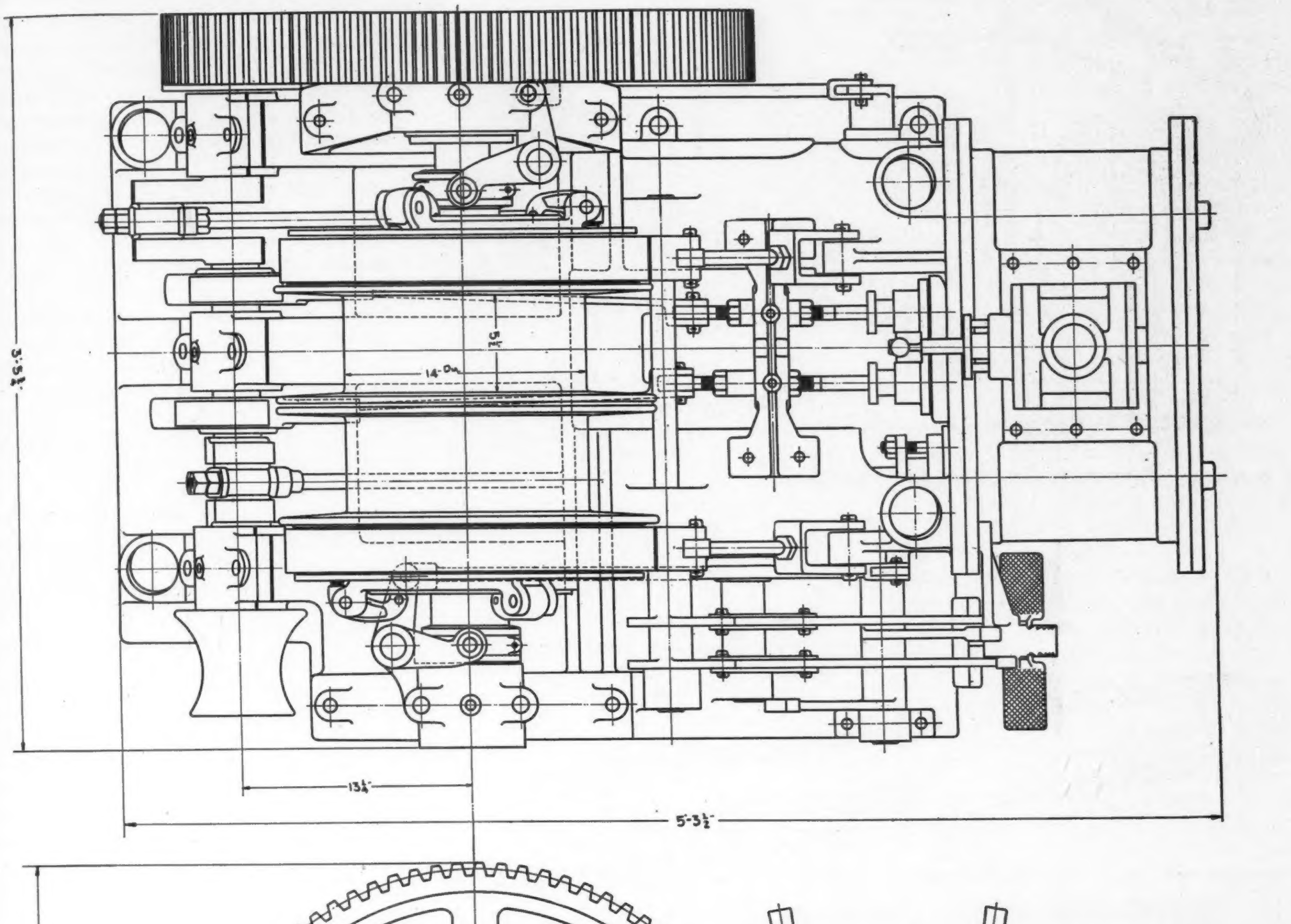


Fig. 13. Motor driven scraper hoist built by Lake Shore Engine Works, Marquette, Mich.



ASSEMBLED DRAWING
6"x9" SCRAPER HOIST
LAKE SHORE ENGINE WORKS
MARQUETTE, MICH.

FIGURE 15

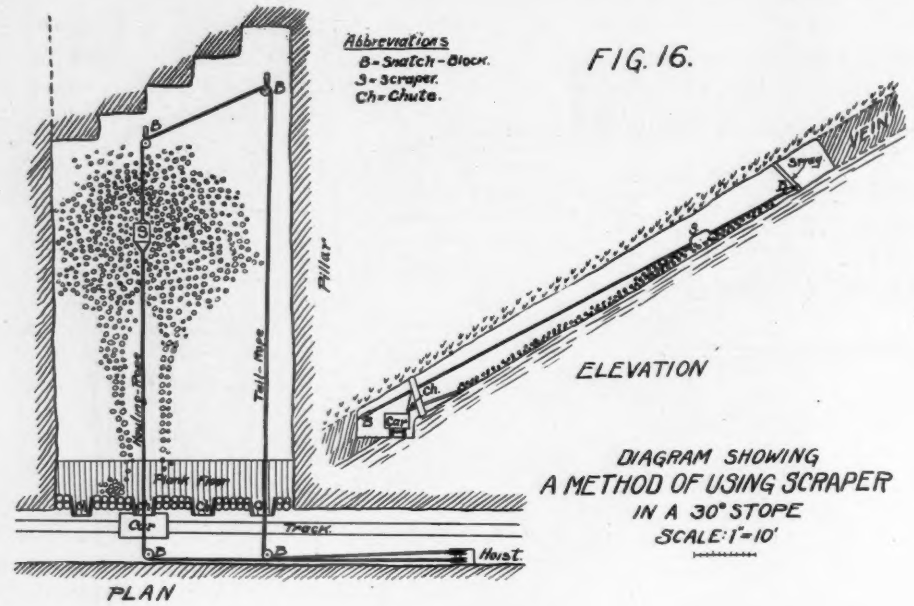


FIG. 16.

DIAGRAM SHOWING
A METHOD OF USING SCRAPER
IN A 30° STOPE
SCALE: 1"=10'

DIAGRAM SHOWING
A METHOD OF USING SCRAPER
IN A FLAT STOPE
SCALE: 1"=10'

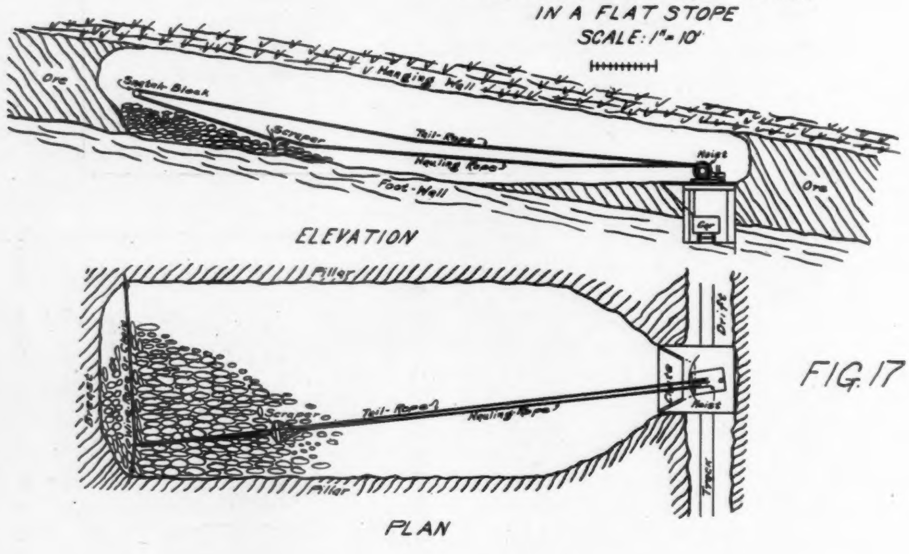


FIG. 17

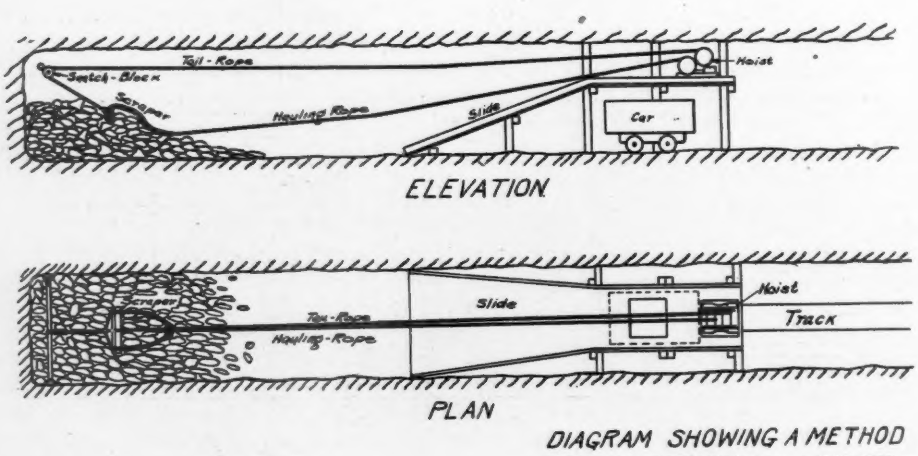


FIG. 23.

DIAGRAM SHOWING A METHOD
OF USING A SCRAPER IN A DRIFT.
Scale 1"=5'

In other words, in order to obtain a larger output it is necessary either to increase wages for the same amount of labor or to decrease the labor for the same amount of wages. The latter is the better scheme for several reasons. In the first place in many places men have been making such high wages that a slight increase is no incentive to change their method of work. This condition is, however, being rapidly corrected. A decrease in physical exertion not only appeals to nearly every man, but it also increases the field of competition, which thereby tends to result in a higher efficiency.

Only a comparatively small proportion of the laboring class are able and willing to do good work with a shovel, even at high wages, but a very large proportion are eager to run a machine for less wages, if the physical exertion is not too great. This can be easily explained in terms of food requirements. A good shoveller or trammer requires about 6500 calories of food per day to keep in condition, but a pumpman or ordinary mechanic needs only 4000 to 5000 calories. The 6500-calorie men are scarce, but 4000 to 5000-calorie men are plentiful.

At present it does not seem likely that scrapers will take the place of shovelling machines in main level drifts, when speed is desired. Shovelling machines have the advantage in loading speed, and they also allow drilling to proceed during the loading period, which is not possible where scrapers are used. This is one of the disadvantages of scrapers. Another is inherent in nearly all mechanical loaders, i. e., sorting is impossible during loading.

In summarizing the situation it is apparent that the advantages of scrapers over hand-shovelling are:

(1) Greater capacity.
(2) Lower cost.
(3) Less manual labor, permitting the use of less powerful men.

The advantages of scrapers over shovelling machines are:

(1) Lower first cost. A scraper, hoist, and full equipment will cost from $750 to $1500, depending on size. A shovelling machine costs from $3,000 to $14,000.
(2) Lower maintenance charges.
(3) Greater mobility and flexibility.

The disadvantages of any kind of mechanical shovelling and loading are:

(1) Cost of equipment.
(2) Impossibility of sorting.
(3) Interruption of drilling operations.

The advantages to be derived from the use of scrapers in those mines where the force of gravity cannot be utilized to move the broken ore from the stopes to the cars so far outweigh their disadvantages that it seems hardly probable that they will ever be discarded. If those men who have been successful in their use can be induced to give the mining profession the benefit of their experience much needless experimenting will be avoided and a great increase in general efficiency will be obtained, which is to be greatly desired.

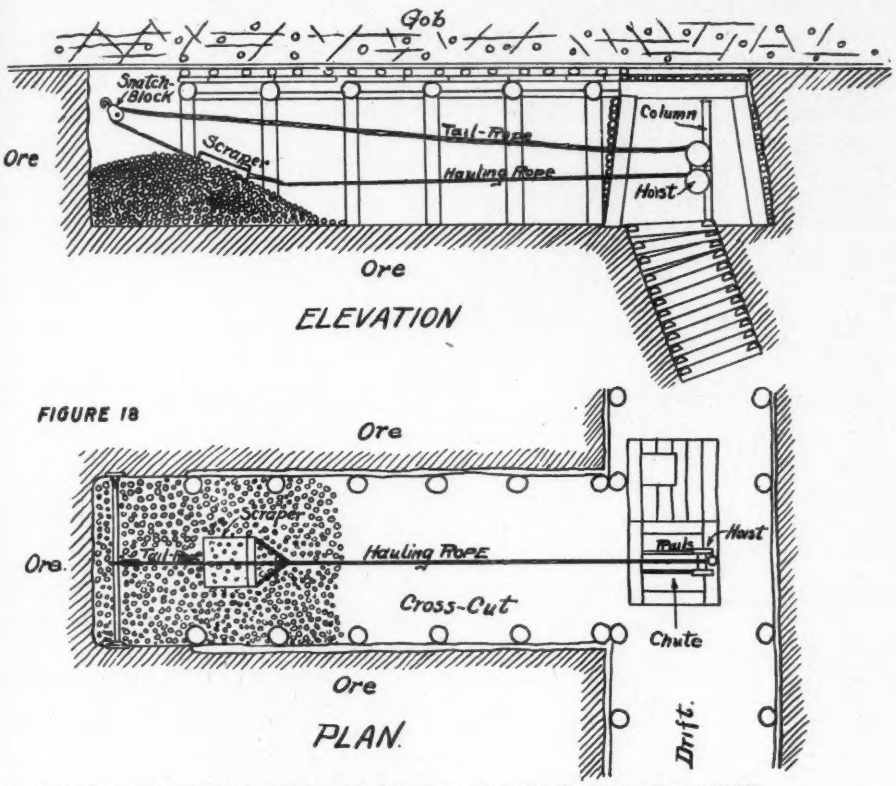


DIAGRAM SHOWING A METHOD OF USING A SCRAPER ON A SUB-LEVEL

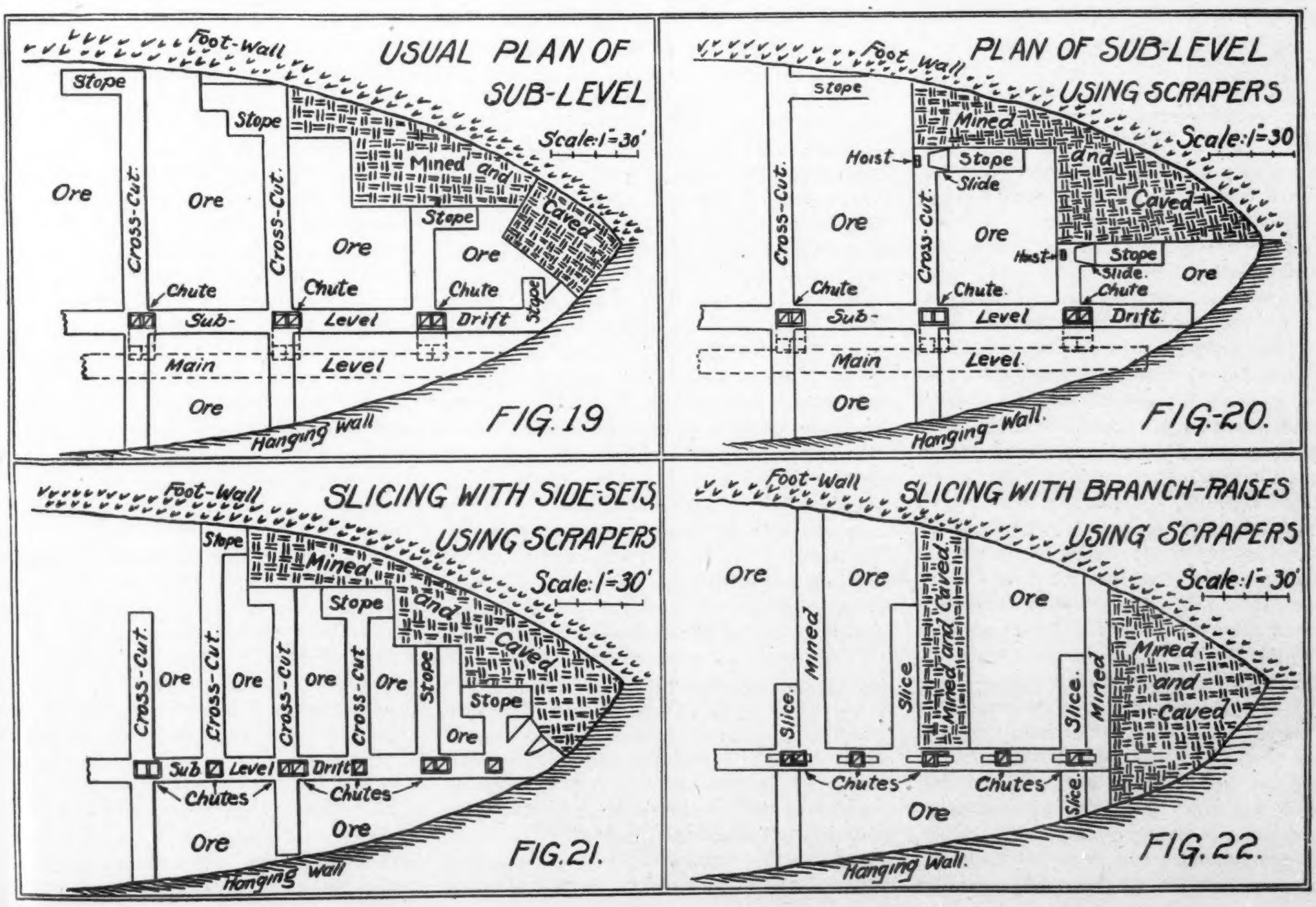
COMPRESSED AIR FOR CONDITIONING CIGARS

In our list of U. S. Patents for February 15 is one for a "Humidifier" which the casual reader is likely to pass without special thought. The following copy of one of the "claims" of the patent, however, suggests a refinement in manufacture which some smokers should appreciate. The claim spoken of is as follows:

"A method of humidifying and flavoring cigars or tobacco, which consists in passing a current of air through a solution of flavoring extract to thoroughly impregnate the air with the extract and in forcing said air through the tobacco or cigars to be flavored."

RUSTLESS STEEL

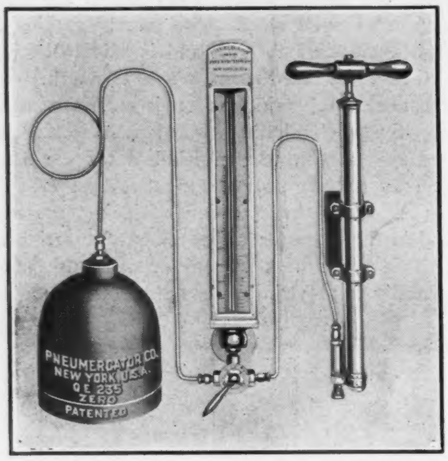
Rustless steel seems to be a completely established fact and it should be looked into for employment in various industries. It is reported on German authority that the Krupp works are paying special attention to the production of such steel. The metal contains a large amount of chrome, and is said to be remarkable for its hardness and strength. Its resistance to chemical action is such that it is not affected by boiling in nitric acid. It is used as a substitute for nickel plated metal in the manufacture of instruments. The firm is also studying the question of using rustless steel in the manufacture of plates for artificial teeth in place of the gold or vulcanite now generally employed.



PNEUMERCATOR DRAUGHT AND TANK GAGES

AIR PRESSURE has been brought to the assistance of the marine and land engineer for measuring liquid depth in tanks or the draught of ships with great accuracy and in a most convenient way. Now that oil fuel is so largely used, and storage tanks on shipboard and on land are required, a convenient method of checking the amount of liquid contained in these tanks is an absolute necessity. The indicator shown in the illustration is simple in construction and operation but yet perfectly reliable.

It consists of a mercury gage, below which is a two-way cock, one side of which leads through a copper tube to a hand manipulated air pump and the other through a copper tube attached to a small metal chamber standing at the bottom of the tank, with an opening into the tank in the lower part of the chamber. The tanks may be of any shape or size, and in any position above or below ground, and the gage conveniently situated in the boiler



Pneumercator draught and tank gage

house, engine room or controlling engineer's cabin. The material measured may be liquid or semi-liquid, under pressure or under vacuum, or of varying degrees of temperature, without affecting the capabilities of the gage.

When it is required to put the instrument into operation, air is pumped into the piping which will be full of the liquid in the tank, the liquid having entered through the orifice in the instrument chamber at the bottom of the tank. The liquid is thus forced out of the piping system and chamber until the ingoing air level reaches down to the orifice in the chamber, when the air pressure will become constant, the pumping in of additional air simply resulting in the escape of the surplus air through the orifice into the tank.

The cock is then turned so that the air is cut off from the pump and the air pressure due to the head of liquid in the tank is recorded on the mercury gage. The specific gravity of the liquid and the section of the tank being known, the exact quantity of liquid contained can be read from a chart. The reading can be simplified when the tank and liquid do not vary, by giving the reading on the gage as a measure of liquid content. There are no fire risks connected with this instrument, and it is practically weather proof. Where it is desired to have warning when the liquid in any tank has sunk to a given minimum, an alarm can be provided which is actuated by means of the pneumercator and this detail alone is of great importance.

The pneumercator is not only valuable for tank content measurement. The navigating officer of a ship can have a series of these instruments beside him, from which he can see at glance the fore and aft draught, the mean draught and the tons displacement. This is particularly valuable when the ship is being loaded. The instrument will perform its work in any weather or sea, and will show the trim of the vessel, and in the event of a leak occurring will indicate exactly whether the pumps are proving effective or not. Every fluctuation of draught, from whatever cause is immediately and accurately recorded. The instrument is a production of Messrs. Kelvin, Bottomley and Baird, Ltd., of Glasgow and London. R. H. B.

DEEP MINING LIMITATIONS

THE FOLLOWING occurs in the presidential address of James Whitehouse before the South African Institution of Engineers. The data he gives carry these suggestions as the difficulties to be encountered in deep mining everywhere.

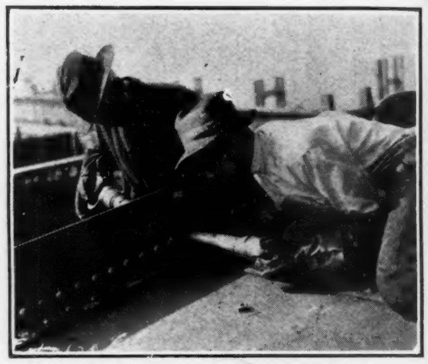
The rock-temperatures continue to rise at the rate of one degree for every 253.9 ft. of depth. From determinations made recently in the Village Deep mine, the rock-temperature at a depth of 5487 ft. has been found to be 89.4° F. The temperature of the air current which reaches to this depth is 72.6°F., dry bulb, and 71.6 wet bulb. This low rise of rock-temperature is probably unique, and compares favorably with the temperatures experienced in the St. John del Rey mine, which is the only mine in the world which is deeper than the Village Deep, and where the air-temperature is 109°F. dry bulb, and the rock-temperature is 114.4°. The depth of this mine is 6126 ft. vertically. At depths between 5000 and 6000 ft. it is necessary to install equipment for circulating large volumes of air.

While the effect of depth on the temperature of underground workings is less serious at the Village Deep mine than, perhaps, in any mining field, this cannot be said of the resulting pressure, and the difficulty which this causes in deep workings. From a comparison of the actual cost of support of the workings on a deep-level mine today and in 1914, it is found that the cost of timbering and rock-walling in 1914 was 10d. per ton crushed, and in 1919 this charge had increased to 2s. 5.4d. On the basis of wages paid in 1914 and the cost of raw material at that time, the cost for this work in 1919 would have been 1s. 9.6d. per ton, that is an increase equal to more than double the 1914 cost. This represents the increase which is entirely due to depth, the difference between the present cost is 1s. 9.6d. per ton, which is 7.8d. per ton, being due to the increase in wages and cost of materials. Similarly the cost of winding has risen from 1s. 8.6d. in 1914 to 2s. 9.7d. for 1919, of which increase 8.5d. is due to depth, so that the cost for this work, apart from charges due to the War, would today have been 2s. 5.1d. per ton. From the above figures, and, quite apart from the increase in operating costs due to the War, the conditions obtaining in deep mines today differ from those of 1914.

DOUBLE RIVETING METHOD

THE ACCOMPANYING illustration shows the double riveting method that is used at the Schaw-Batcher Shipyard in South San Francisco.

Both the holder-on and the riveters use a gun. With the standard rivets the holder-on uses the snap die, leaving a round head on the rivet and assuring a tight job. With counter sunk head rivets a saucer die is used which also makes a nice, neat, water-tight job and


Double Riveting at Schaw-Batcher shipyard.

eliminates the necessity of caulking the heads. The number of defective rivets is greatly reduced when this method of riveting is used.

It is pointed out that in this method the holder-on receives a thorough training in the use of a riveting gun and in a short time becomes a proficient riveter and may be advanced to a higher grade and salary. Also the average rivets per gang is increased and a very much greater proportion of the rivets are tight and pass inspection.

FILIPINOS MAKE FIRE BY COMPRESSED AIR

The natives of the Philippine Islands produce fire by what is called a fire syringe. This is really a highly scientific device, says *The San Francisco Chronicle.* A piece of very hard wood has a small hole bored in it, and into this hole a rod fits closely, a piece of cotton wool rendering the joint airtight. At the bottom of the hole a small piece of tinder is placed.

When air is strongly compressed it becomes heated; so that when the natives force the rod down the hole, the air is violently compressed and the tinder is so heated that it begins to smolder; then the rod is withdrawn and the tinder is immediately fanned into a flame.

This process is based on an old laboratory experiment, which may be found in text books, it may be noted.

The Three Rivers Pulp & Paper Co. of Montreal, has engaged Mr. J. J. O'Sullivan to revise plans for a pulp mill to cost $1,500,000 and to be erected at Three Rivers, Quebec.

Tin Mining In Cornwall, England

Descriptive Data on Rock-Drilling and Other Underground and Surface Operations in Excavating and Concentrating Tin Ore

By ROLAND H. BRIGGS

General view of Tolvaddon tin mill

TIN MINING in Cornwall at the present time is passing through the same readjustment stage that is occurring in all other metal mining districts. It is difficult to make a profit with the present cost of operations when the price of tin is around £200 per ton. There is plenty of tin in Cornwall, and modern equipment and efficient methods prevail, but it is difficult to raise capital for development without an immediate prospect of improved conditions.

Probably no better example could be found of tin production in Cornwall than the East Pool and Agar Mine, Ltd., and the Tolvaddon Tin Mill and Dressing Floors, all managed by Messrs. Berwick Moreing & Co. Ltd. of London.

By the courtesy of their superintendent, Mr. M. T. Taylor, M. I. M. M., the writer was permitted to examine the whole process of tin production as practised in Cornwall, from the mining of the ore to the separation of the finished product known as "black tin."

Compressed air for the rock drills used in this mine is generated in the compressor house, and in the present state of development about 1,000 cubic feet of free air per minute is required, which will increase as the mine is extended. The capacity of the present compressors, amounting to about 2,500 cubic feet per minute, is ample even for probable future requirements, and gives a good reserve of power in hand at the present time.

The air is carried in six-inch, five-inch and four-inch mains, and fed to the working faces in two-inch and one and one-half-inch pipes, although not more than four drills are worked from the one and one-half inch pipe except in abnormal circumstances. The pressure at the receiver is maintained at about 84 lbs. per sq. in., giving a pressure at the working face of from 70 to 80 lbs. per sq. in.

An efficient and easily understood record of progress in the mine is kept in the offices on glass sections, in addition to the usual detailed plans and maps of the workings, and these glass diagrams show very clearly the various levels and the direction of the lodes. The superintendent, Mr. Taylor, past president of the Cornish Institution of Mining and Metallurgy, member of Council of the Cornish Chamber of Mines, and a member of the Institution of Mining and Metals, is well-known as an inventor of a plane concentrator for the treatment of slimes, having a capacity of 60 tons per day and of a process for the flotation of tin ore, a demonstration of which was afterward given to the writer in a visit to the laboratory.

Equipped with acetylene lamps, the underground manager, Mr. W. Kemp, and the writer, descended the mine to the 190 fathom level. It should be explained at this point that the winding in the East Pool Mine is carried out by steam, drilling entirely by compressed air, which is also used when required for driving small standby pumps, main pumping by electric-motor-driven centrifugal pumps, and tramming entirely by hand, except on the 212 fathom level where ponies are used.

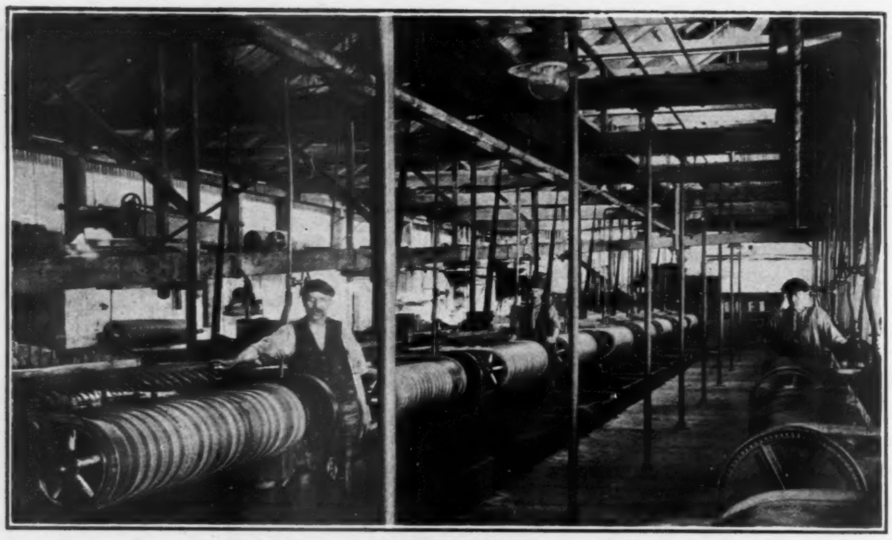
The main shaft is 322 fathoms (1,932 feet) deep, and contains the main water uptake, up which the water is forced by three Rees Roturbo centrifugal pumps direct connected to Mather and Platt 260 horsepower electric motors. Each pump has a capacity of 750 gallons per minute on a 600 foot lift. The material hoist handles about 7,000 tons of ore per month, this amount being possible owing to the systems of ore bins used, into which the ore can be dumped direct from the trucks and loaded to the skip, instead of the latter being filled with the shovel.

Only one stable is provided for the ponies as these are used at present only on one level, and after blasting, the material is loaded from the ore, passes to the trucks, or directly into the trucks from stope chutes, the capacity of the trucks being fifteen cubic feet and the average distance trammed about 700 feet.

The temperature in certain stopes approaches 90 degrees Fahrenheit, but is much lower in the roads. The drills used are the normal types of stope drills and jackhammers, and some notable drilling has been recently done. A new tunnel is being driven, ten feet wide and eight feet high, in hard

Concentrating Tin Ore at Tolvaddon Mill

Handling concentrates at Tolvaddon Mill



A section of the Tolvaddon mill

Concentrating tables at Tolvaddon mill

granitic rock, and in this four drillers working abreast with four telescopic water drills, advanced 260 feet in a month, working in four shifts of six hours each.

The average time taken from rigging up to clearing was two and one-half hours, and the average consumption of free air per drill amounted to 50 cubic feet per minute per machine. The average power per drill was twelve horse power, and the distance of the air compressor from the drills is 3,500 feet. The average number of holes put in per machine per shift is 36, and the average depth of holes drilled about two and one-fourth feet. The mean effective depth broken for each round of holes is about two feet.

The average tonnage broken per machine per shift is about three and one-half tons. Four men are employed in this tunnel in tramming and shovelling. Each shift rigs up, bores out the face, pulls down, fires out, and removes the broken material, four rounds of two feet being taken out in the 24 hours.

In driving the Tolgus Tunnel in the Agar Mine on the 255 fathom level, an even better record was set up, a distance of 220 feet being driven in one month, and in this case the advance being made in one drive only, so that the drillers had to throw back part of the material after blasting before they could get their posts rigged up again.

In the East Pool mine tunnel, on the other hand, the tunnel was driven at both ends, so that the drillers could rig up and drill at one end while the muckers were clearing away the blasted material at the other. While it is recognized that greater advances than the above have been recorded in America, these are not directly comparable with Cornish conditions, where an average advance of about 70 feet per month is generally considered satisfactory.

At the 190 fathom cross-cut the writer saw part of the famous Great Lode, which yielded such enormous quantities of ore in the past, and then went into the Rogers Lode, which is producing a large part of the output obtained at the present time. He was then taken east as far as the Elvan, and then north into a drive where the Rogers Lode, which is of considerable richness at this point, was examined. A side stope was climbed into, where men with jackhammer drills were engaged in blasting out the material to bring one level into line with another.

Returning to the shaft, the cage was again entered, and the party then descended to the 212 fathom level. The depths of all these levels are marked and spoken of in fathoms, although in other parts of Britain distances are quoted in feet. This is probably due to the fact that in the old days the Cornishmen were essentially fishermen, and only went into the mines when the fishing was slack. Their depth unit of measurement on the sea was the fathom, and it was therefore natural that the same unit should be used on land. A survival of the same period may be noted in the very general use of the word "Cap'n," for anyone in authority underground, the name by which the fisherman was wont to address the man in authority over him on the water.

In the 212 fathom level the first point visited was the ponies' stable, where "Queenie," who was off duty, was duly admired and fed. The ponies have good quarters and are brought up to the surface every three weeks, and usually haul two trucks at a time at a good rate of speed, the man often riding on the last truck. The number of horses and ponies used for mine and quarry haulage in Britain is very large, amounting to over 66,000 last year.

On this level the Rogers Lode was again seen north of the Elvan, and going west from this point several back stopes were visited. Men were at work in the stopes with water drills and others in underhand stopes with jackhammer drills, all on the Rogers Lode, and all working in eight hour shifts. The party then descended to the 240 fathom level, where the various lodes were passed through in succession, the Red Lode, Great Lode, Middle Lode, New North Lode, Bramwell's Lode and the Rogers Lode. The working face was sprayed down with water so that it was possible to examine it properly, and the richness of the ore was again noted.

The 252 fathom level is reached by means of ladders down the Great Lode from the 240 lode, and here the cross cut was entered where the record of 260 feet advance in one month mentioned above was obtained. This was at the north end of the tunnel, and at the south end the shaft was reached, where preparations were in hand to take down the wooden barriers and open up this end of the tunnel to the shaft.

After five hours underground the writer returned to the surface, and having changed the garb of an imitation miner to that of an ordinary citizen, was taken to the Tolvaddon tin mill and dressing floors. It would be difficult to say whether the mine or the mill was of the most intense interest. The first building visited was the laboratory, where a demonstration of Mr. Taylor's flotation process for tin and other oxides was given by the chief chemist on the experimental plant installed in the laboratory.

The ore is brought from the East Pool and Agar mines by electric haulage and after passing the stone crushers is dumped into the air cushion, rock crushing stamps which are situated at the highest point of the sloping ground on which the mill is built. From this point the ore is carried practically throughout its journey by gravity, large diameter bucket wheels being used at one or two places to elevate the crushed ore and water, so that the gravitational effect may be assisted.

The mill at present contains ten double-head air cushion stamps, and additional stamps are being added shortly. These stamps have an output ten times as great as the ordinary "Californian" type of falling stamp. From the stamps the ore is washed down to the "James" and "Wifley" sand and concentrating tables, and to "Frue" vanners. The "Taylor" concentrating table can also be seen at work, and the regrinding of the sands is done in grit and tube mills.

The "Taylor" concentrating table is an adaptation of the principles of the "rack" and "round" frames combined, and a very large table of this type is under construction for Bolivia, which is to deal with from 60 to 70 tons of fine tin slimes per day.

Rock drill scene at East Pool Mine

The Borlase buddles and rack frames are still used quite extensively in the Tolvaddon plant, and from the concentrating machinery the product passes to the calciners, where the arsenic and sulphur are removed. Two magnetic separators are then used to finally separate the tin oxide from the other metals. The magnetic separators in this plant are so arranged that the iron is delivered through the first two ports into suitable bins, the wolfram is then secured by the higher magnetic current above the third rectangular traveling band, and the tin oxide known as "black tin" is finally delivered into a bin at the end of the machine. The usual sulphuric acid tanks and other appliances are provided for the treatment of any material which, owing to the molecules of tin and wolfram being combined together, cannot be effectively dealt with by the magnetic separators.

The above all too inadequate description gives some general idea of the methods followed in tin mining and preparation as practised in Cornwall, and it is considered that while it it not possible for the Cornish tin mines to compete in price with the producers who are working the alluvial deposits of the Straits Settlements, the Cornish ore is sufficiently

Operating rock drills in the East Pool Mine

Ore stamps at Tolvaddon mill

plentiful, rich and accessible, to make it possible for the mine proprietors to hold their own in competition with the other underground mining areas of the World.

PNEUMATIC CLEANING OF AUTOMOBILES

A new time and labor saving process for cleaning automobiles is being introduced. It is stated that an automobile can be thoroughly and quickly cleaned inside the garage, but preferably outside, and regardless of temperature. The apparatus consists of a long nozzle held by the operator through which a mixture of air, oil and water is sprayed on the automobile frame, axles or engine at a uniform pressure of about 90 pounds per square inch. The nozzle discharges the mixture in the form of a spray, which is directed against the surface to be cleaned at an angle of about 45 degrees from a distance of 18 inches. One gallon of oil is used to about 300 gallons of water, the proper mixture being secured by regulating valves attached to a special oil tank. The mixture of oil and water is carried to the nozzle by a ¾-inch rubber hose, the stream being broken up at the nozzle by air supplied through a ½-inch nipple. The temperature of the water used is about 100° to 120° Fahr., and the oil is a light-colored gas oil or petroleum distillate having a paraffin base.

The safety in the operating of the passenger elevators in the business offices of New York City is marvelous and it does not merely happen so but results from the excellent and rigid inspection. On each of the 313 working days of 1919, 6,000,000 passengers were carried through the 10,000 miles of shafts of the 13,500 elevators, making a total of 1,878,000,000 passengers for the year, and only one was killed out of each 87,500,000 carried.

Just recently a new paper machine in the mills of the Wausau Sulphate Fibre Company, Mosinee, Wis., successfully and steadily made 20-pound Kraft paper 112 inches wide at a speed of 1,000 feet per minute, thus leaving all previous records far out of sight.

HOW TO MAKE PIPE BUSHINGS OUT OF STANDARD PIPE

By W. F. SCHAPHORST

IT IS a good thing to know that bushings can be made out of standard pipe. Many pipe fitters don't know that it can be done. Or, if they know that it can be done they don't know the correct size of drill to use for tapping. I have always known that it can be done and have occasionally made bushings out of pipe, but each time I found it necessary to first look into my handbook for the drill size to use and that is so much trouble that it is frequently easier to go to the store and buy a new bushing. Recently, though, it has been very difficult to buy bushings in stores on account of shortage of all pipe fittings, hence I feel that the following information should be of much value. I have collected all of the data together for all bushings that can be made out of ordinary sizes of extra heavy and double extra heavy piping.

To bush from ¼″ to ⅛″, for example, get a piece of ¼″ extra heavy pipe sufficiently long for cutting the outside thread. Then cut the end off to the desired length, drill or ream with a 21/64″ drill (diameter of drill 0.328″) and then tap with a ⅛″ pipe tap. That's all there is to it.

The table below tells the complete story for all ordinary sizes: Note that in one case, ⅜″ to ¼″, the internal diameter of ⅜″ extra heavy pipe is such that no drilling is necessary.

Also note that in bushing from ½″ to ⅜″ either extra heavy or double extra heavy piping can be used.

To Bush From	Use this Size Pipe	Use this Size Drill or Reamer.
¼″ to ⅛″	¼″ extra heavy.	21/64″ drill =0.328″.
⅜″ to ¼″	⅜″ extra heavy.	None.
½″ to ⅛″	½″ double extra heavy.	21/64″ drill =0.328″.
½″ to ¼″	½″ double extra heavy.	27/64″ drill =0.422″.
½″ to ⅜″	½″ double extra heavy.	9/16″ drill =0.562″.
½″ to ⅜″	½″ extra heavy.	9/16″ drill =0.562″.
¾″ to ⅜″	¾″ double extra heavy.	9/16″ drill =0.562″.
¾″ to ½″	¾″ double extra heavy.	11/16″ drill =0.688″.
1″ to ¾″	1″ double extra heavy.	29/32″ drill =0.907″.
1¼″ to 1″	1¼″ double extra heavy.	1/18″ drill =1.125″.
1½″ to 1″	1½″ double extra heavy.	1/18″ drill =1.125″.
1½″ to 1¼″	1½″ double extra heavy.	1-15/32″ drill =1.468″.
2″ to 1½″	2″ double extra heavy.	1-23/32″ drill =1.72″.
2½″ to 2″	2½″ double extra heavy.	2- 3/16″ drill =2.187″.
3″ to 2½″	3″ double extra heavy.	2- 9/16″ drill =2.562″.
3½″ to 3″	3½″ double extra heavy.	3- 3/16″ drill =3.187″.
4″ to 3½″	4″ double extra heavy.	3-11/16″ drill =3.688″.
4½″ to 4″	4½″ double extra heavy.	4- 3/16″ drill =4.187″.

WOOD CARVING BY SAND BLAST

A process of carving wood by special application of the sand blast is giving highly satisfactory results in California especially when applied to the redwood of that State. Portions of the surface are covered by protective stencils which leave figures in relief and a uniform background. Very rich effects are produced in paneling the walls of a dining room, hall or den. While much of the work is done in the natural color of the rich, reddish brown wood, striking color effects are brought out by the use of paints, deep blues, reds, browns and gilt.

Plans are under way for the merging of the Alpha Portland Cement Co., Easton, Pa., and the Cement Securities Co., Denver, Colo., the new company to be called the Alpha Cement Co.

SAND, GAS MANTLES AND SPARKING METALS

SOME CURIOUS information occurs in a report on Thorium, Zirconium and Rare-Earth Minerals by W. T. Schuller, just issued by the U. S. Geological Survey. Here is a sample:

Incandescent gas mantles are made by impregnating a woven hood with thorium nitrate, which is then calcined to the oxide. Thorium compounds are extracted from monazite, a mineral that is mined in the form of sand. Therefore gas mantles and monazite sand are closely related, for it is the oxide of thorium, which glows intensely when heated, that makes the light from a gas mantle so superior to a bare gas flame. Where now does the sparking metal come in? Monazite contains not only thorium but some other rare-earth metals. Among these is cerium, compounds of which are obtained as a by-product in the extraction of thorium, and it happens that more of these are produced than anybody has known what to do with. Cerium is a soft metal that throws off glowing particles when scratched, and it is therefore used in various forms of gas lighters and pocket lighters for cigars. It is too soft to use alone so it is alloyed with iron to make sparking metal.

A copy of the report can be obtained free on application to the Director, U. S. Geological Survey, Washington, D. C.

Mr. Charles A. Witherell metallurgical engineer, has opened an office at 150 Nassau St., New York City.

AN INDUSTRIAL FILM FEAT

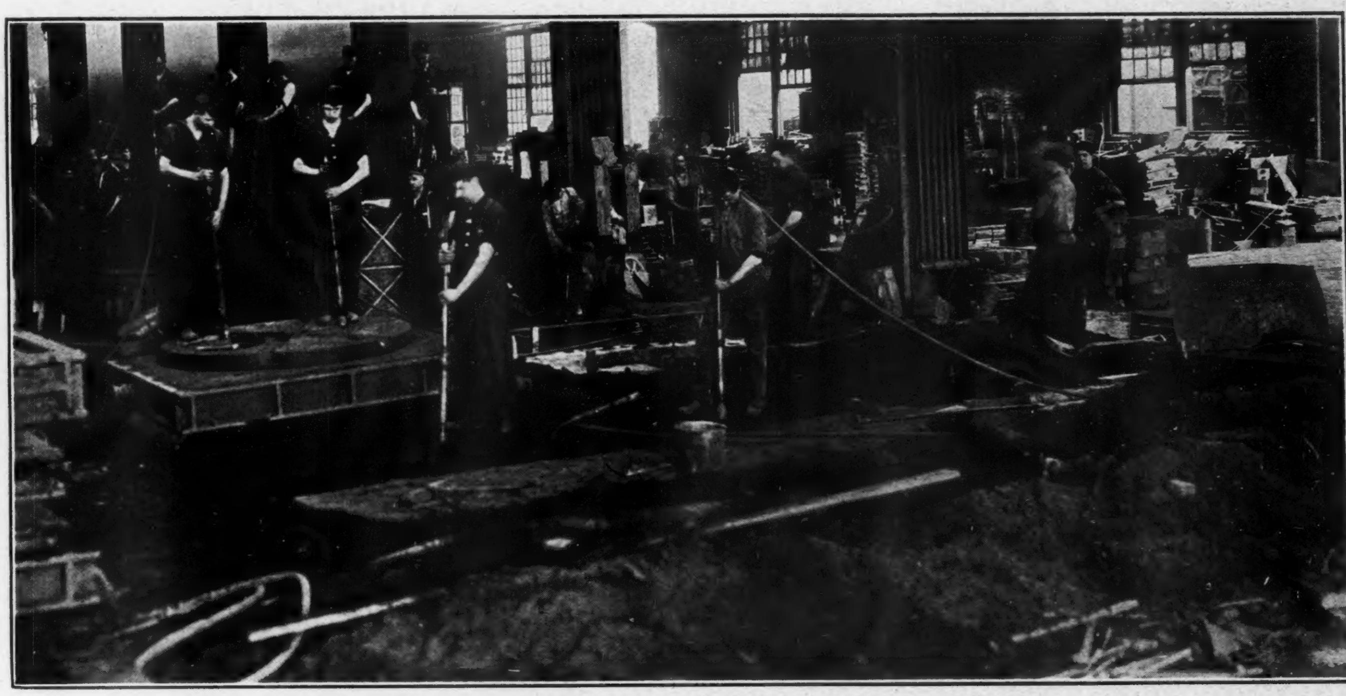
The American Rolling Mill Company has prepared a 3000-foot moving picture film of operations in its Middletown, O., plant. One of the scenes shows the molten metal in an open-hearth furnace at a temperature of approximately 3000 degrees, Fahr. The Rothacker Film Co., Chicago, were the photographers. This company claims the main obstacles in the path of the undertaking were the possibility of the lens cracking or the heat and light of the metal exploding the film. Before being used exclusively for sales purposes the owners will send the picture to technical schools and engineering societies.

D. R. Luce, engineer, is preparing plans for a steel roller mill and fabricating plant to be erected by the Peden Iron & Steel Co. of Fort Worth, Texas. Electrically operated machinery costing about $1,000,000 will be installed.

Compressed Air in the Foundry and the Steel Mill

How Pneumatic Devices Are Used to Speed Up Production, Reduce Costs and Increase the Percentage of Satisfactory Castings

By ROBERT G. SKERRETT



Pneumatic sand rammers ramming up molds for wheels and cylinders.

THE MAN in the street, the so-called average citizen, has a general consciousness that the metallurgical industries of the United States are monumental, but his understanding is hazy when it comes to the division of importance among these many and varied activities. Broadly, he is aware that the production of iron and steel dominates, and he visualizes the plants so engaged as more or less imposing aggregations of blast furnaces and rolling mills that, successively, reduce the primary ore to metal in the common conception of the term, melt great masses of scrap material for reworking, and then by some means form the steel or iron into the plates, shapes, and bars required for multitudinous uses.

But the moment you ask him where our foundries stand in the realm of our metallurgical enterprises he is all too frequently apt to give them a position of minor consequence, simply because relatively little has appeared in the popular press to make him familiar with this department of endeavor.

And yet, where should we get our modern bath tubs; how should we obtain our hundreds of thousands of stoves, ranges, furnaces, and radiators; whence would the farmer turn for so many of his implements essential to the cultivation of the soil and the harvesting of his crops; how should we model the great water wheels that utilize the power of our flowing streams; what should we do for the locomotives, and the millions of car wheels and automatic couplers that make present-day transportation possible; and how could we manufacture engines and machinery, of all sorts, automobiles, motor trucks, etc., in vast numbers if it were not for the foundries that can supply metal articles in large quantities and in weights ranging from a few ounces to tons?

Indeed, the foundry is virtually indispensable or basic in the metal industries, for from the very start molten metal must be given a form to meet an immediate purpose or be so cast that it will lend itself subsequently to working into shapes of innumerable kinds. According to the most recent figures, our great steel plants produced last year substantially 40,500,000 tons of ingots—raw material from which to make thousands and thousands of widely differing steel commodities for a bewildering list of services.

None of these ingots could have been provided without the aid of molds, and every one of the latter had its origin in the iron foundry. This fact is mentioned merely that the reader may get some grasp of the bigness and the standing of the foundry in the metal trades. Again, to promote popular appreciation, there were fabricated in 1920 no fewer than 2,241,000 automobiles, and many essential parts of each one of these vehicles had to be cast; and, during the same twelvemonth, we had registered on our railways quite 8,500,000 cars, in the make-up of which the foundry figured conspicuously.

It would be possible to continue to cite figures of an imposing character, but surely enough has been said to bring home to us that the helpful activities of the foundry concern every walk of life to a greater or lesser extent.

And now let us come to the story we want to tell: how compressed air plays a valuable part in the truly modern foundry. The present-day aim is to speed up production, to reduce foundry costs, and to make reasonably sure of getting a high percentage of satisfactory castings. All of this entails the substitution of mechanical agencies for hand work wherever practicable.

We have reached a stage in the mechanic arts where we can no longer rely upon manual skill for many of the operations required in the foundry—first, because labor is too high and, next, time too precious to permit us to jog along in our erstwhile leisurely way. And, besides, we cannot compete with the foreign manufacturer unless we utilize facilities that will offset the much lower wages which he pays competent craftsmen. Compressed air and America inventiveness have, together, given us the means whereby the foundry can be speeded up without sacrificing quality.

Many of us recall that the foundryman makes use of two-part flasks or frames in which he packs sand around imbedded patterns—the lower casing, which is filled first, being called the "drag," and the upper one, which completes the molding of the sand around the pattern, is termed the "cope." When this work is done, the two sections of the mold are carefully separated and the split patterns

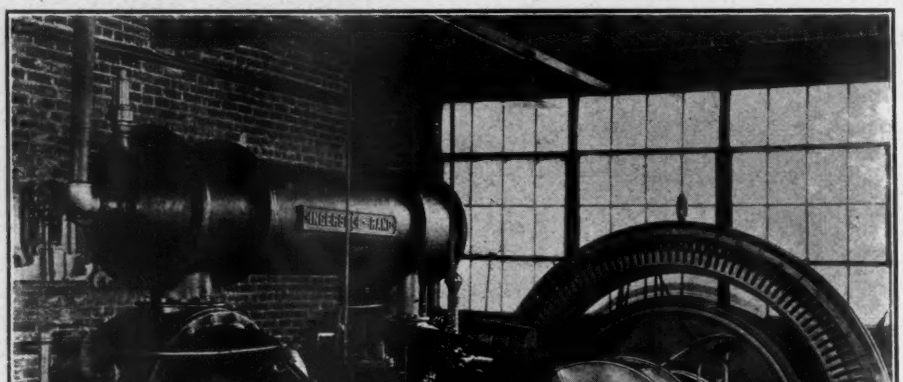
removed, thus leaving accurate impressions of them in the sand.

The molder then finishes nicely any irregularities of the impressed surfaces where the sand may have been disturbed in withdrawing the patterns or where contact has not been effected during the packing of the flask. Further, if the cavity created by the pattern is not to be filled solid, then the molder skilfully secures in place one or more "cores," of prescribed sizes and shapes, which are enveloped by the molten metal and subsequently knocked out or washed out.

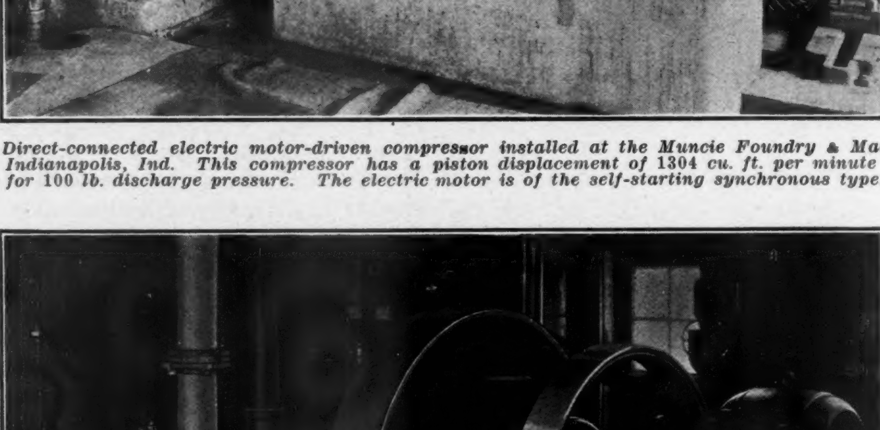
When the molder has each half of the mold ready to his satisfaction, the cope and the drag are brought together once more and locked.

At that stage the sandy mass in the upper section of the flask is pierced by vertical passages which lead down into the modeled cavity so that the fluid metal may descend while the gases formed may find easy outlet. All of this sounds fairly simple, and yet much labor and perhaps a deal of exquisite workmanship may be called for on the part of the molder in order to insure a perfect casting after the metal has been teemed.

If he fail to do his work well the casting may be deformed, its surface may be too rough or so pitted with blow holes as to make it unacceptable, or it may have other defects that necessitate much subsequent treatment to render it marketable. These short-comings can be pretty generally attributed to incomplete packing or ramming of the sand around the pattern.



Direct-connected electric motor-driven compressor installed at the Muncie Foundry & Machine Co., Indianapolis, Ind. This compressor has a piston displacement of 1304 cu. ft. per minute suitable for 100 lb. discharge pressure. The electric motor is of the self-starting synchronous type.



Class "ER" compressor used for supplying air in a foundry. It will be noted that this compressor is driven by an electric motor by means of short belt drive.

In up-to-date foundries hand ramming is disappearing, for better and quicker results can be obtained by recourse to pneumatic rammers. Compressed air is preferably the impulse medium because it lends itself readily to many added services in the foundry, and it has not the drawbacks which characterize steam or electricity in this environment.

Pneumatic sand rammers of various sizes are provided, and these are principally designed to meet two conditions of packing molds either on a bench, where a short tool answers, or for ramming molds on the foundry floor, for which a longer outfit is desirable. Without going into the structural niceties of these labor-saving apparatus, it suffices to say that the operator has only to press a conveniently placed throttle lever to make the tool function while he guides it.

The bench rammer is a moderate-sized affair, weighing from eleven to thirteen pounds, and is intended for work on small flasks such as are ordinarily handled on the bench. It is capable of delivering 750 blows per minute. On large molds, however, which are so constructed that the floor rammer cannot reach all sections effectively, the bench rammer comes to the rescue and is frequently used to great advantage.

The floor rammer weighs 22 pounds, and when operated by air at a pressure of 80 pounds, deliveres 600 blows a minute. It imposes no stretch upon the imagination to picture the rapidity with which either of these tools can pack sand firmly in a flask and about a pattern. For general tamping the rammer carries a cone-shaped butt, and for getting into corners and close to the contours of the pattern a substitute fan-shaped attachment, technically known as a pein, is provided. On an average, a mold can be rammed by a pneumatic tool in one-fifth the time required to do that work by hand.

But the gain is something more than that of saving time and making it possible for the foundry operative to get through his day's task with less exhaustion while showing a larger measure of accomplishment. No small part of this success is due to the weight and way the equipment is built, for these two factors can be so coördinated as to induce a minimum of jar or reaction when running and yet give sharp and strong blows. In short, the workman is not needlessly fatigued by vibration. Air-driven tools of this sort make it feasible to ram the flasks harder and more uniformly than by the older hand method.

Therefore, the walls and mass of sand supporting the pouring cavities are firmer and better able to resist any disruptive forces set up by the metal as it flows into these recesses. By reason of this state of the mold the metal is not wasted in the formation of fins, etc., that have to be removed afterwards, nor does it contribute to the production of objectionable overweight castings. In other words, the products are far more likely to be true to

Sand blasting stove parts at Prizer & Painter Stove Works, Millmont, Pa.

Jarring out cores from automobile aluminum casting with "Little David" core breaker.

Lifting a flask by means of a two-ton hoist at the W. A. Jones Foundry Co., Chicago, Ill.

pattern and unvarying in weight and quality.

The ramming of molds, especially for small castings and where identical multiples of these are made in large numbers, is often done by means of jolt ramming and jarring machines. In these, the vibratory motion, by which the sand is packed about the patterns, is imparted by a suitable mechanism operated by compressed air.

Again, there are power squeezing molding machines, and these, under the impulse of compressed air, bring the mold flasks together, and firmly tamp or force the sand to the proper density about the patterns. Where machines of this sort are used the patterns are frequently made of aluminum, because of its lightness answering admirably. Further, through a vibratory movement induced pneumatically, after the molds have been rammed, the patterns are shaken free so that they can be lifted or withdrawn without marring the impressions in the sand. These machines are numerous in design, and the purpose of all of them is to reduce labor to a minimum while promoting the rapid pouring of many castings during a single working shift. Compressed air is peculiarly fitted to play the part of energizing medium because the air has a distinctive cushioning effect and yet is positive and vigorous in its action.

Jarring apparatus, ingenious as they are, have their limitations, and the work done by them is not always complete enough to obviate finishing touches with the man-guided pneumatic rammer. According to one eminent foundryman: "For medium-size work that is made in quantities, we believe the jolt machine to be indispensable; even with this, however, the sand rammer is a very important factor in butting off the tops of the jolt-rammed molds. When larger patterns are rammed it has been our experience that the sand rammer is equal, if not superior, to the jolt machine. This statement is made after taking into account the expense and labor incident to rigging up a pattern for use on a jolt machine, the tendency the mold has to sag upon being rolled over, the bolting on of the plates before rolling the drag and such other details as are encountered in rolling over a large job. On the other hand, if the pattern is bedded in the ground or flask and rammed up with pneumatic rammers, which may be done with unskilled help, much of the expense and delay is eliminated, while we are sure of a perfectly true job conforming to every detail of the pattern. And it may be said positively that pneumatic rammers can be used on both copes and drags indiscriminately and with equal success."

Compressed air in the foundry does not end its service with the functioning of sand rammers and the operating of jarring and molding machines. The worker, in finishing his mold prior to the teeming of the molten metal, finds this handy source of energy of material aid to him. Any one acquainted with the procedure in many small and even large conservative foundries is familiar with the hand bellows ordinarily employed by the artisan for blowing off mold surfaces and getting loose sand, etc., out of corners and other more or less troublesome recesses.

To-day, he is able to do this better and quicker by recourse to an "air gun" that supplies a steady stream, which he can regulate to a nicety to suit his needs. In making up his mold, the molder must have within reach plenty of sand, in fact he usually requires several kinds according to the nature of his task and for different parts of the mold. Not only that, but the sands must be sifted and in a state for him to handle effectively.

Pneumatically-actuated sifters have been developed of divers types, and some are portable while others are intended to do their work at a permanent location in the foundry. The portable apparatus saves the time and expense of wheeling sand to and from the screen in supplying the molder—the sifter can be set up anywhere, generally close to the mold. It has been authoritatively said, speaking of the economies made possible by these sifters: "Including the cost of air, based on an efficient compressor installation, and allowing the current rate for labor, it is entirely practicable to effect a substantial saving in view of the fact that one man with one machine will screen in a single hour as much sand as a man would ordinarily riddle by hand during a working day." The larger the foundry and the greater the quantity of sand to be dealt with the more reason for the adoption of mechanical sifters of this sort.

Among the several aims of the molder is that of facilitating the peeling of the casting from the sand. As may be readily understood, the intensely hot, fluid metal would naturally be expected to fuse some of the sand forming the mold walls and thus to cement it to the solidifying iron, steel, brass, etc.; and knowing that this admixture of sand and metal must be removed to make the casting acceptable, the molder resorts to an expedient to reduce or to prevent this undesirable action. That is to say, he coats the surfaces of his mold and cores with a film of blacking, and this tends, when the blackening is done well, to hold the sand and the metal apart. According to the size and complexity of the mold and its associate core or cores, skill and possibly a good deal of time are required to do this work properly. Once more compressed air does its bit; and a simple and rugged type of atomizer has been devised which meets the demands of this service.

Up to now, nothing has been said about

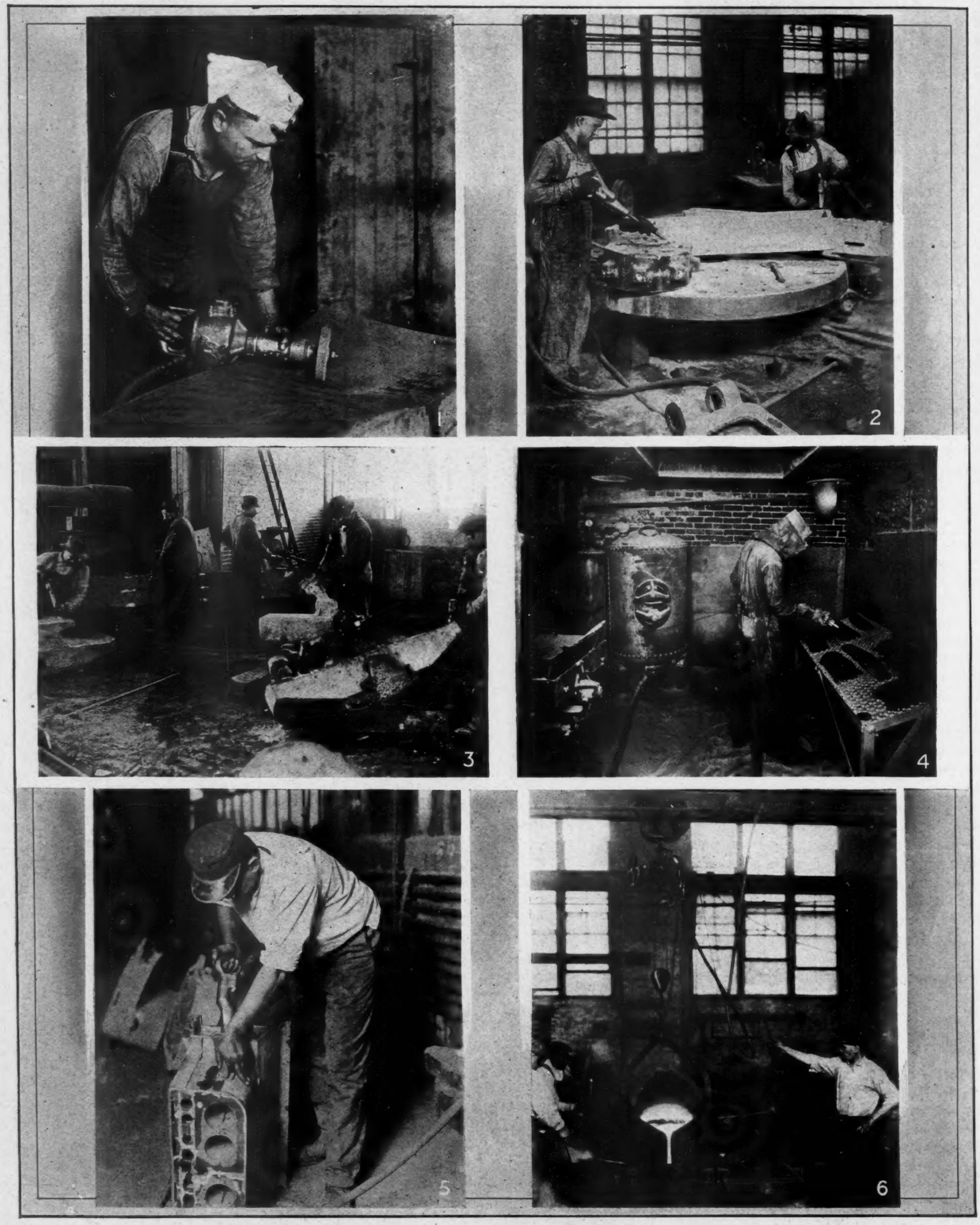


Fig. 1. International Metal Stamping Co., Detroit, Mich.. No. 7 "Little David" grinding metal stamping dies. Fig. 2. Breaking out cores at foundry of Marion Steam Shovel Company, Marion, Ohio, with No. 5 hammer. Fig. 3. "Little David" chipper in the plant of the Standard Process Steel Corporation, Phillipsburg, N. J. Fig. 4. Sand blasting at the Prizer & Painter Stove Works, Millmont, Pa. Air furnished by Ingersoll-Rand compressor. Fig. 5. No. 1-S chipper on automobile cylinder castings at D. J. Ryan Foundry Co., Ecrose, Mich. Fig. 6. Two ton "Imperial" hoists used for pouring on moulder floor at foundry of W. A. Jones Foundry Co., Chicago, Ill.

labor saving through mechanical lifting; and yet it should be self evident that the flasks, the prepared molds, and the ladles charged with their incandescent contents have to be shifted from point to point during the preparatory stages and the actual teeming of the metal. For these various functions the air hoist is especially suited. "Similarly, when the molder has finished with his patterns, and when the castings are cold and ready to be moved to another part of the foundry, the pneumatic hoist again comes into play. After the patterns of large castings have been drawn from the "cope" and "drag" it is necessary to set the cope on the drag by a mechanical hoist and the penumatic geared hoist is far more satisfactory than any other type of hoist owing to its delicacy of operation which enables the operator to accomplish this without jarring loose the sand. The pneumatic hoist is so simple in its working that a boy, with its aid, can lift a given load a dozen times while a gang of several men, using a chain block or windlass, would be raising the same weight once.

By such an instrumentality as the air hoist it is practicable to keep the floor space cleared and to shorten the stages in the shop history of any job.

The prevention of confusion on the floor, giving the men plenty of elbow room in which to work at their best, and the general speeding up of output inevitably adds to the profitable returns. This pneumatic apparatus, in its perfected form, permits the load to be raised and then held at any point desired.

In the actual melting of the metal in the furnace or cupola, and in preparing the ladles to receive the molten metal for pouring, compressed air has useful functions to perform. Compressed air may be used to atomize the oil when liquid fuel is employed in the furnace or for otherwise stimulating the draft to promote combustion and the generation of necessary heat. And the air torch similarly serves to raise the temperature of the ladles so that they will not chill their charge when the metal is teemed into them prior to pouring the molds. In passing, it should be said that the air-operated oil torch is doing good work in many foundries in skin drying and baking molds and cores and likewise in salvaging condemned castings.

And now, assuming that the casting has been made, the next problem is to clean the product. The labor involved in this will, of course, depend upon the size and character of the casting and the degree of surface finish demanded by the customer or the service to which the commodity is to be put.

In large and somewhat complicated castings the first thing demanding attention, after the newly formed metallic mass has been lifted free of the sand, is that of getting rid of the cores which, primarily somewhat firm, have been baked and further hardened by the contiguous molten iron, steel, brass, etc. Clearing away cores by hand is a toilsome and expensive procedure, and to save time and work pneumatic core breakers have been devised. These tools are extremely effective and efficient and do much to reduce foundry costs. They will remove in an hour big cores that it would otherwise take a good deal longer to dispose of.

With the cores out of the way, if such have been used, the succeeding steps involve breaking or cutting off the "sprues" and the "gates" —projecting columns or necks of metal formed in the passages by which the metal flows down into the mold cavities, fins, vitrified adhesions of sand and metal, and other deformities.

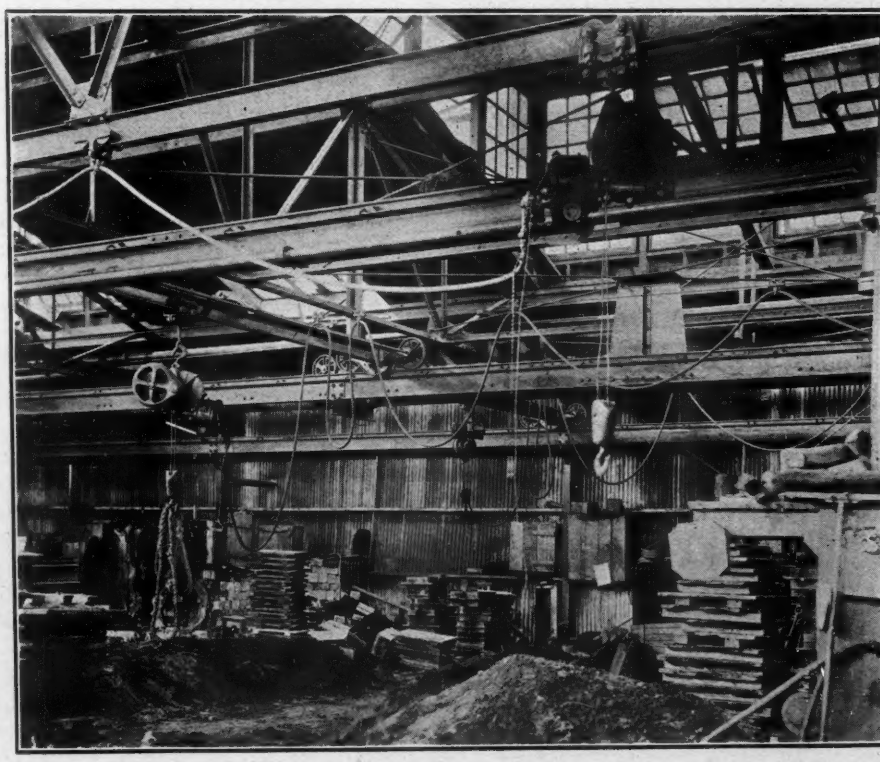
To meet these several conditions, air-driven hammers, chippers, and grinders have been evolved, and, as might be expected, they can be confidently counted upon to do their work well and quickly. But there is another agency that is largely relied upon to clean the surfaces of castings and to bring them to that state of smoothness desired after the irregularities just described have been dealt with. This is the sand blast. The term sand blast is self explanatory, and consists in exposing a casting or castings to an artificial sand storm impelled by compressed air.

Formerly, sand blasting was decidedly unhealthful work, but the operative is now safeguarded from the harmful dust by a suitable respiratory equipment in the form of a helmet, etc. It is practicable to regulate the air pressure and, therefore, the impinging force of the abrasive agreeably to the character and the material of the individual casting. A few examples will show the economies made possible by the sand blast. By the old hand method a car coupler would require two and one-half hours to clean, while the sand blast can do it in less than five minutes. Gas engine cylinders are surfaced in 30 minutes by air blast as against four hours by the tedious manual procedure; and a 4,000-pound ingot mold, together with cutting out its twelve-inch core, has been cleaned in 60 minutes by sand blast—effecting a saving of nineteen hours.

Sand blasting has been brought to a high stage of development, and an up-to-date installation for the speedy handling of large and numerous castings is made up of a sand-blasting machine, a sand-separating machine, a sand elevator, an exhauster, and a dust arrester. As authoritatively described: "The sand-blast machine is placed in a separate compartment from the sand-blast room and is arranged to operate through the dividing wall quite as well as if it were directly in the blast room.

By this arrangement the sand-blast compartment is devoid of hampering appointments or apparatus, giving that much more working space, while the sand-blast machine is not exposed to the injurious or wearing action of sand and dust. The sand, after being blown upon the castings, falls through a grated flooring into a hopper, whence it is carried to the elevator boot, and the latter transports it to the sand-separating machine, where pieces of material, larger or smaller than desirable, are sifted out and deposited into a bin. The clear sand for re-use is dropped into another bin directly over the sand-blasting machine.

"The dust-laden air is taken from the blast room through suction pipes located beneath the grating. In going through the dust arrester, the dust is thoroughly separated from the air and falls into convenient hoppers. The clean air is then passed back into the room through spaces in the ceiling. This system insures proper ventilation." It seems, where comparisons are made between cleaning by pickling and cleaning by sand blast, that a very handsome saving both in labor and



Compressed air hoists at the plant of the Michigan Steel Castings Co., Detroit.

A molding machine installed at the McShane Bell Foundry, Baltimore, Md. The air used in connection with this molding machine is supplied from a 9 in. x 3 in. stroke air compressor.

time can be effected by the pneumatic equipment.

And while on the subject of sand blast, let it be said that this cleansing medium has been very effectively applied in dealing with small castings when they are rolled in the tumbling barrel. By adding a sand blast, which discharges into the barrel through the center of one of the supporting bearings, the castings can be cleaned quicker and better than where dependence is placed entirely upon the rotating action of the container.

As time goes on, ways multiply by which the price of castings can be lowered through applications of compressed air, and no wonder that the progressive foundryman finds it well worth his while to provide his plant with a compressor and to have recourse to pneumatic tools and apparatus wherever he can put them to service. As a source of motive energy, in this field of service, compressed air is notably superior to steam for it is not subject to the same frictional and radiation losses in distribution; and when an air hose, a valve, or a connection leaks, air does not present the same physical hazards as would escaping steam. How many people know that we have in the neighborhood of 6,000 foundries here in the United States severally engaged in turning out gray iron, malleable iron, steel, brass, bronze, copper, and aluminum castings, or that the gross business of a certain group of these foundries, dominated by a single company, was in the neighborhood of $60,000,000 in 1920?

By way of conclusion, just a brief reference to the service of compressed air in our steel mills. The blast furnaces or converters obtain their operative breath from the lungs of powerful blowers; and then compressed air is not infrequently used to free hydraulic lines of their water, to blow them dry, to prevent them from freezing when not in use during periods of cold weather. The pneumatic drift-bolt hammer can be readily adapted to the work of cleaning out open-hearth furnaces, and is, in fact, so employed at some plants. But pneumatic tools, such as grinders and chippers, are especially valuable in finishing off the blooms of high-grade steels and the surfaces of special-process steel plates.

In the ingots of alloy steel there are frequently shrinkage cracks on the metal that have to be got rid of lest their oxidized surfaces refuse to weld subsequently when passing through the rolls—thus forming lines of structural weakness likely to break when subjected to service stresses. Therefore, in order to promote the welding, so much desired, pneumatic chippers are used to cut out the cracked areas and to produce gouged channels having sound and bright surfaces which, when heated to a proper degree of incandescence, will come together under pressure and make a perfect bar, etc.

In the getup of some of our fighting ships, especially dreadnoughts, battle cruisers, etc., the vitals are extensively protected by decks and bulkheads of special-process steel. From the very nature of the composition of this material, surface defects are apt to develop after rolling, and to remove these blemishes the pneumatic grinder answers admirably. By thus disposing of these superficial defects, paint is given a chance to take a firm grip upon the faces of these sheltering barriers, in this way keeping moisture at bay and preventing the start of destructive oxidation. Otherwise, rust might eat into and weaken bulkheads below the waterline and cause them to fail at the critical moment when exposed to the disruptive blast of a torpedo or a submarine mine.

It is not possible to present in a lump sum the economic benefits resulting from the employment of compressed air in the foundry and in the steel plant, but inasmuch as pneumatic appliances have been instrumental in reducing labor costs by as much as 50 per cent. in some directions; have cut down the time of manufacturing processes tremendously; have made it feasible to obtain the while superior castings and products; and have very measurably lessened the quantity of defective commodities, the broad benefits can be grasped.

In one city in this country more than 600,000 stoves, ranges, and furnaces were cast last year. From this fact alone the average person can gather an inkling of what the foundry means to the comfort and convenience of the country's habitations; and in this example of contribution to the general needs we have but one in many hundreds.

MOVING PICTURES OF MINING OPERATIONS

Two new educational motion picture films of the mining industry, "The Story of Asbestos" and "The Story of Sulphur," are now ready for public distribution by the Bureau of Mines.

"The Story of Asbestos," in six reels, was produced by the Bureau of Mines in co-operation with the H. W. Johns-Manville Company. This picture illustrates in detail the methods employed in the mining of asbestos in Arizona and in Quebec, and also shows the manufacturing processes used at the Johns-Manville Company's plants in New Jersey and New Hampshire.

"The Story of Sulphur" was produced by the Bureau of Mines in co-operation with the Texas Gulf Sulphur Company, and shows in detail the methods of production, storage and transportation employed at the plant of this company at Gulf, Texas.

The Bureau has also prepared a film on the production of ingot iron, made in co-operation with the American Rolling Mill Company.

These films had their first public showing at the meeting of the American Institute of Mining and Metallurgical Engineers in New York on February 16.

Inquiries in regard to the loaning of these films for educational purposes should be addressed to the Pittsburgh station of the Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

HOW NATURE PROVIDED A VENTILATING SHAFT

While driving a tunnel in the Cortez mining district the owners of the mine were about to install expensive machinery for ventilation when nature came to their aid and made the expenditure unnecessary, says the Elko, Nevada, *Free Press*.

At about the 1,400-foot point an open fissure was penetrated and a natural upcast of air through this fissure immediately cleared the tunnel of powder smoke. Arrangements had been made to secure a powerful ventilating fan, but the use of this device was rendered unnecessary and a considerable expense was avoided by inserting the air-pipe in the fissure and sealing the remaining space. The outlet to this fissure, somewhere on Tenabo mountain, has never been found, but this mysterious crack in the solid rock, nearly 1,000 feet below the mountain top, replaces power and equipment of no insignificant cost in providing air suction.

Air Hoists Save Time and Labor in Porcelain Enameling Plant

Ingenious Arrangement of Small Pneumatic Hoists Effectively Aids in the Handling of Materials Used in the Production of Enamel Coated Sheet Iron

By LINWOOD H. GEYER, M. E.

IT HAS often been said that in some way or other, compressed air enters into the production of almost every manufactured article. While many of us associate compressed air with mining, steel construction, rock drilling, and numerous other operations, too few think of the ever-increasing use of this power medium in the many plants grouped under "Industry," where many of our familiar everyday articles are made. For instance, how many men and women looking at the enamel ware in their homes realize that air has helped not only in the actual process of its manufacture, but also in the method of handling material necessary for its preparation. The housewife probably never appreciates how intimately compressed air affects her daily routine. She never realizes how compressed air facilitated the manufacture of her handsomely enameled kitchen table top, the stove, cooking utensils and many other modern conveniences that she enjoys.

Porcelain enameling is not a new process for in the ancient Egyptian days it was used for jewelry. There are also records showing its use by the Italians for ornamental purposes and of its further development by the French. Its use for kitchen ware, however, was introduced by the Austrians and for many years the use and application of porcelain enameling was developed and fostered by the Germans and Austrians.

In these earlier days, white and other light colors were not extensively used, the manufacturers confining themselves almost exclusively to the darker colors. During the past fifteen or twenty years, however, the tendency has been toward light colors, especially white, and during this period the industry has flourished in the United States.

At the factory of the Porcelain Enamel and Manufacturing Company, Baltimore, Md.,—manufacturers of "Pemco" products—the process has been developed to a high degree of perfection. This company not only manufactures procelain enameled parts for other concerns, but installs complete plants for users of this material. There is little need here of entering into the detailed process of manufacture but a description of several ingenious uses of pneumatic hoists should prove both interesting and instructive.

Formerly chain hoists and trucks were used exclusively for lifting and transferring the stamped sheet iron parts and the materials which enter into the preparation of the porcelain enamel. After the sheets have been stamped and annealed they are taken to the pickling room where it is necessary to lift and submerge the stampings into various tanks filled with acid and water, in order to prepare the metal surface for the first coating of porcelain enamel.

With the old chain hoists this was a tedious process involving a great deal of hand lifting and lowering and both the time consumed and the actual work were excessive. A "Little David" air hoist, having a lifting capacity of 1,000 pounds, was substituted with the result that one man is now able to do the work which formerly required two, to say nothing of the relief afforded the operator.

Figure 2 is an interior view of the pickling room and Figure 3 illustrates the work done by the hoist. This air hoist is mounted on a trolley which runs on a monorail clamped to the ceiling. The character of this work is such that rail switches are unnecessary, although with the monorail system almost any arrangement of switches and cross-overs can be installed. The operator lifts the load by pulling one throttle handle and lowers the load by pulling the second handle, the hoist being so constructed as to handle the load suspended at any point without the use of air power.

The swinging bracket carrying the air hose prevents undue wear on the hose and also keeps it from interfering with the workman. This makes it a very simple matter to dip the basket holding the parts in and out of any one solution as well as transferring the load from one tank to the next. Moving the load from one tank to another merely involves pulling the hoist or basket.

In the room where the porcelain enamel is mixed and prepared the hoisting problem is more complicated. Here no absolutely uniform system can be followed it being necessary to have the hoist available for use in all parts of the room without any definite sequence of operations. For this reason the overhead monorail system is not a closed circuit but involves switches and cross-overs. A very clever and simple arrangement has made it possible to use the hoists where they are needed and then keep them moving to the desired point with the smallest possible loss of time. The arrangement of switches also makes it possible to use a minimum number of hoists and keeps the machines in operation continuously. Since the Porcelain Enamel and Manufacturing Company has substituted "Little David" air hoists for chain hoists they have performed three times the work in this department with the same number of men. Figure 1 shows the mixing room mentioned above and the arrangement of the hoists.

I was informed by Mr. K. Turk of the Porcelain Enamel and Manufacturing Company that he had solved still another problem with the air hoist. The company was in need of a small elevator for hoisting materials from the basement to the working floor. As the use of hand trucks was proving both costly and slow the installation of a small electric elevator was planned. The cost of such an arrangement was found to be considerable and, as the lift was only about fifteen feet, Mr. Turk hit upon the idea of rigging up a cage and lifting and lowering it with another hoist similar to those mentioned above.

Accordingly, a small cage was built and the hoist installed on the upper floor. No steady operator is required as the man above raises the loaded cage by means of the hoist, takes off the load, lowers the cage so it will be ready

Fig. 1. Interior of mixing room. Here "Little David" air hoists are used to lift and transport the materials. Note the monorail system and the ingenious arrangement of the air hose.

Fig. 2. View of the pickling room showing monorail system and "Little David" air hoist for transporting material.

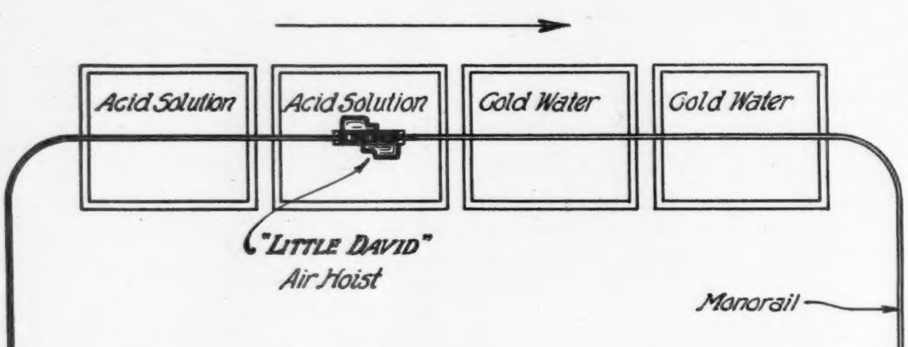


Fig. 3.—Plan of pickling room where a "Little David" air hoist lifts the material to and from the different solution tanks and transports the material through the different processes necessary in its production.

for the next load, and trucks the material to where it is needed. Practically all of the raw material used in manufacturing the porcelain enamel is handled on this hand-made elevator and no trouble or breakdowns have been experienced to date.*

In coating the surfaces, the metal is either dipped into tanks containing the liquid solution or porcelain enamel is applied by means of air brushes—in some cases both methods are used. The use of the air brush here not only saves time but has made possible a far better product. The enamel is quickly applied and an even, uniform surface is obtained.

The Porcelain Enamel and Manufacturing Company also operates a modern wood-working department for making wooden tables on which porcelain enamel tops are used. Here compressed air jets are used for cleaning and the company is now considering the installation of air paint brushes for enameling the wood work.

The compressed air plant consists of an Ingersoll-Rand, Class "ER" Compressor, having a single, double-acting cylinder, twelve-inch bore by ten-inch stroke, with a rated piston displacement of 324 cubic feet per minute. This compressor is driven by a standard 50 horsepower electric motor by means of a short belt drive attachment.

*We know of similar elevator applications where the lift is too great for this type of air hoist, and in such places where hoists having larger drums with greater cable capacity have been installed it has been found that "Little Tugger" Hoists will meet these conditions very satisfactorily.

THE CEMENT GUN IN RAILWAY WORK

The following items are embodied in a report of the Committee on Roadway of the American Railway Engineering Association, presented at the March convention:

In 1914 the New York Central Railroad used a cement gun in its Spuyten Duyvil Cut on the main line, about ten miles north of Grand Central Terminal, New York City. This is probably the most extensive work of this sort yet attempted. The cut was 500 feet long with sides 80 and 50 feet high, respectively. The Third Rail System furnished the power for operating the air compressors. The first operation was to remove the small loose stones and dirt from the crevices by air, before using the cement, and it was thought advisable in some places to use anchor bolts one inch in diameter in order to insure holding up some of the larger rock, the mixture of one to three parts cement and sand was then used. This work was done in 1914 and 1915, was inspected by a member of the committee in June, 1920, and found to continue satisfactorily.

In 1914 the Lehigh & New England Railroad at Lansford, Pa., used the cement gun in the roof of a tunnel, part of which was lined with brick, the balance not lined. Some of the brick had fallen out; others had become loose; the rock in the unlined portion frequently fell to the track, but after treatment with cement gun the condition was corrected. There are several streams of water emptying on to the track from the roof of this tunnel, which the manufacturers of the cement gun claim can be sealed up. This work will be attempted by the Lehigh & New England Railroad very soon.

AIR ACTUATED LOCKS FOR SAFETY LAMPS

THE IMPERATIVE requirement for safety in a miner's safety lamp is that it shall not be opened in the mine atmosphere while it is lighted. Too many miners will take the risk of opening their lamps regardless of this danger and various ingenious devices are employed for locking the lamps. An air-lock is now sometimes employed. This air lock consists of a lock bolt held in place by a spring, the bolt fitting tightly in a recess. To open the lamp the suction end of a vacuum pump of such strength as to be found usually only in the lamp house, is placed over the bolt. The vacuum draws the bolt outwards even against the retaining force of the spring. The lamp bowl can then be unscrewed and the lamp opened. Variations of this type of lock are used. In some, the positive pressure of compressed air is employed to force back the bolt.

An air mail and passenger service between Manila and other ports in the Philippines is being organized. The war department announces that it has purchased five seaplanes from the navy department and that the flying personnel will be formed of 30 officers of the Philippine National Guard.

The Wave Power Rock Drill

By FRANK RICHARDS

THE CONSTANTINESCO system of wave power transmission is one of the most ingenious inventions of recent years; it is not yet possible to foresee the full scope of its applicability, and little if any opinion can be formed as to its ultimate practicability. The development of the interrupter gear in the machine guns carried by airplanes in the Great War, enabling them to shoot between the arms of a swiftly rotating propeller, proved the invention, merely as an invention, to be deserving of the highest consideration. As to how much effective work it actually did we are not informed.

The employment of the same principle in the operating of rock drills suggests the wide range of its applicability, announcing it at once as a competitor of the pneumatically operated tool so pretentious as to demand more than casual notice in the pages of COMPRESSED AIR MAGAZINE.

The system of wave power transmission as applied to the operating of rock drills is not so entirely new as may be at first suggested, since we have notices in COMPRESSED AIR MAGAZINE of its exploitation in South African mines several years ago, although no satisfactory description of the device and no clear explanation of the principle upon which it operates were given.

And, indeed, the device is so different from those to which we have become accustomed and so at variance with familiar practice that it is not easy to describe it, and also it can be no easy task to intelligently follow out any description that may be prepared.

Although in this case water is to be regarded as the operating fluid, there is no direct employment of pressure and no positive thrust from a movable column of liquid. We are aware that the matter is not made any clearer —except as later we may look back upon it by the suggestion that the method has much the same relation to hydraulic transmission that an alternating current bears to a direct or continuous current in electrical transmission.

It depends intrinsically on the fact that water, as well as other liquids, is slightly compressible, and has in consequence a certain degree of elasticity. When an impulse is set up by a power generator at one end of a column, a wave of impulse travels through the latter and gives up its energy at the far end. Energy is transmitted from one point to another by means of impressed periodic variations of pressure or tension producing longitudinal vibrations in the column. If the energy be imparted by a piston we have alternate zones of high and low pressure, and the disturbances so produced travel forward along the tube until the whole of the particles are in a state of vibration.

Taking the most simple case, if a working piston is connected to a rapidly rotating crank, so that it moves with a simple harmonic motion, and the column is of considerable length, the motion of the layers of liquid nearer the working piston is resisted by the inertia of the more remote layers, and on the in-stroke of the piston the liquid in its neighborhood will be compressed and its volume diminished; it follows that the motion of the layers of liquid remote from the piston will be less than that of layers nearer to it. At any given speed of rotation of the crank there will be a point in the liquid column at which, on the completion of the in-stroke of the piston, no movement of the liquid has occurred. The liquid between this point and the piston will at this moment be in a state of compression varying from maximum at the piston to zero. At the moment of maximum velocity of the piston, the velocity of the layer of liquid in contact with it will necessarily be greater than the velocity of the more remote layers, and the kinetic energy of the layers nearer the piston will, therefore, be transmitted in the forward direction along the column. The energy expended by the piston in its forward stroke at the end of this stroke is present in the liquid column, partly in the form of potential energy due to the decreased volume of the liquid under compression and partly as kinetic energy.

On the return stroke of the piston, the compression of the layer of liquid in contact with it decreases, and expansion of the liquid takes place between the piston and the point in the column at which the pressure is a maximum. As the point of maximum pressure moves away from the piston at the commencement of the return stroke, the velocity of the layer of liquid in contact with the piston is reversed, while the pressure of this layer diminishes until the piston is at the end of its out-stroke. At the end of this out-stroke the layer of liquid in contact with the piston is instantaneously at rest.

As the crank continues rotating, there are thus impressed on the liquid column a series of impulses sending a series of changes of pressure and volume along the column, the particles of liquid each vibrating about a mean position.

In order that a receiver may be able to respond to the vibrations falling on it, certain conditions are essential. The part of the receiver which is to be put in motion must be capable of vibrating at the periodicity of the vibrations which fall on it, and if the part moved has to perform useful work, that the work should be performed in such a manner that the ability of the receiver to vibrate in unison with the impressed vibrations is not interfered with. If more energy is put in by the working piston than is taken up by the piston at the other end, assuming no frictional losses, it is obvious that reflected waves must be formed. The result of this will be that the surplus energy will remain in the liquid and the continuation of the rotation will continually pour in energy, increasing the maximum pressure indefinitely till ultimately the pipe will burst. If, however, a vessel completely filled with liquid, of considerable volume in proportion to the stroke volume of the working piston, and with rigid walls, is placed in communication with the pipe in the neighborhood of the piston, this will act as a spring, taking up the energy of the direct and reflected waves when the pressure is high, and giving back this

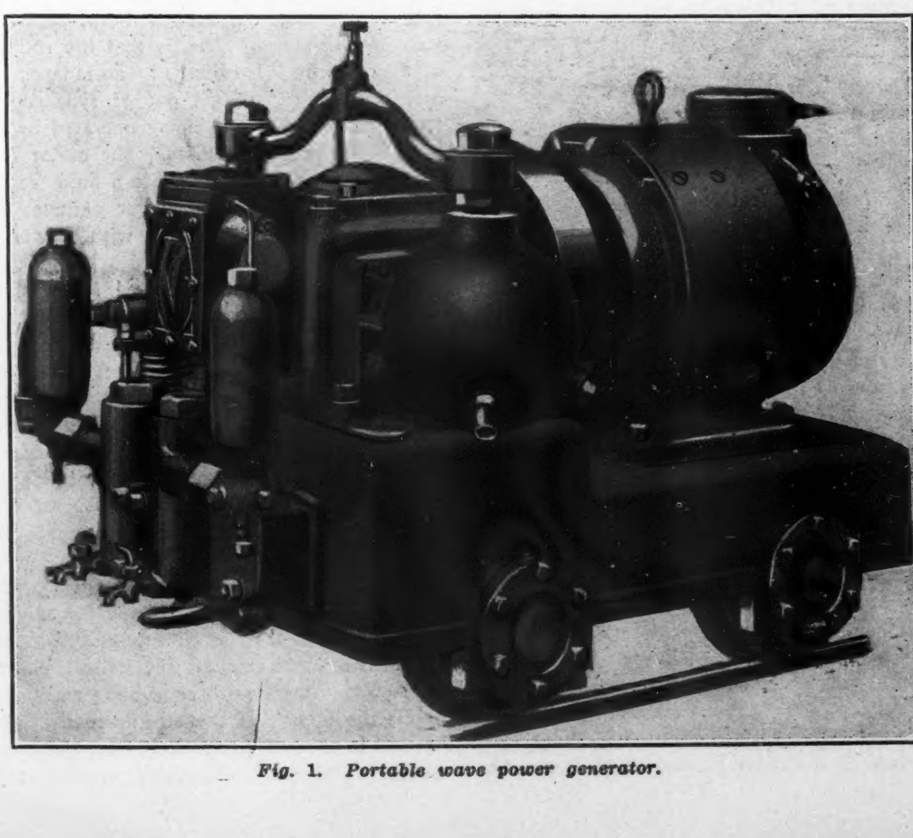


Fig. 1. Portable wave power generator.

energy when the pressure falls. The result of this is that when the reflected waves have been produced, there will be a series of stationary waves in the pipe, and no further increase of energy in the liquid will take place and the pressures in the pipe will never exceed the fixed limit.

Practical Wave Power Generators

Wave power generators are now manufactured by W. H. Dorman & Co., Ltd., Stafford, England. They are made in sizes from ten horsepower upward, and are suitable for frequencies up to 50 cycles per second, the one shown in Fig. 1 developing ten horsepower at 40 cycles. It may be driven by any of the usual means of mechanical transmission.

The essential elements of a wave generator are as follow: Bed plate, crank case, crank shaft and bearings, "capacity," connecting rod, crosshead, guide and plunger. The following auxiliaries are embodied also in the complete plant: Lubricating oil pump, water feed pump, and tank, if not integral with bed plate.

The characteristic features of the generator are two spherical hollow steel castings designed to suit the pressures adopted, termed "the capacity." The vessels are connected by a pipe at the top, the function of which is to equalize the pressure in each and enables the whole energy of the generator to be taken from either vessel. At the highest point of the balance pipe is a small needle valve for releasing any air that may get into the system.

Screwed into the left-hand spherical vessel is an inlet charging valve actuated by pressure difference. When the minimum pressure in the capacity is greater than the pressure of the pump, it is closed; but immediately upon the pressure in the capacity being (due to loss of water) lower than the pump pressure, it opens. Thus, the inlet charging valve is automatically operated and controls both the rate and time of delivery of the water into the system. In the generator is fitted a water pump of the plunger type, operated by worm and worm wheel driven through cross shaft and eccentrics from the crank shaft. The oil pump is also of the plunger type and driven in a similar manner.

The following features are common to both the oil and water services: The driving shaft runs in ball bearings and has a ball thrust bearing at each end to take up any end thrust due to the angularity of the teeth in the worm and worm wheel, thus permitting the generator to be run in either direction. Attached to the eccentrics are phosphor bronze connecting rods having spherical lower ends which fit in the socket of the push pads or tappets. The connecting rods and tappets work in guides made of close grained cast iron. The plungers are operated by the tappets, contact between these parts being maintained by compression springs. The oil and water tanks have internal wire gauze filters. Provision is made to relieve the pumps of any shocks by means of air vessels placed on the delivery pipes. The pump driving gear is fully enclosed by a housing bolted to the crank case. An inspection cover is provided at the front of the housing.

Keyed to the driving head shaft is a half-coupling. The flywheel, which is heavy, is machined from a steel casting. Steel coupling pins are secured at one end in the half-coupling, the opposite ends fitting in Ferodo bushed holes in the flywheel, thus forming a flexible coupling between generator and driving head. The driving head is fitted with fast and loose pulleys, the latter being of slightly smaller diameter so as to relieve the belt tension when the generator is not working. A belt shifting lever is provided. The shaft and loose pulley are mounted on ball bearings. Each of the main bearings is lubricated by a Stauffer grease cup.

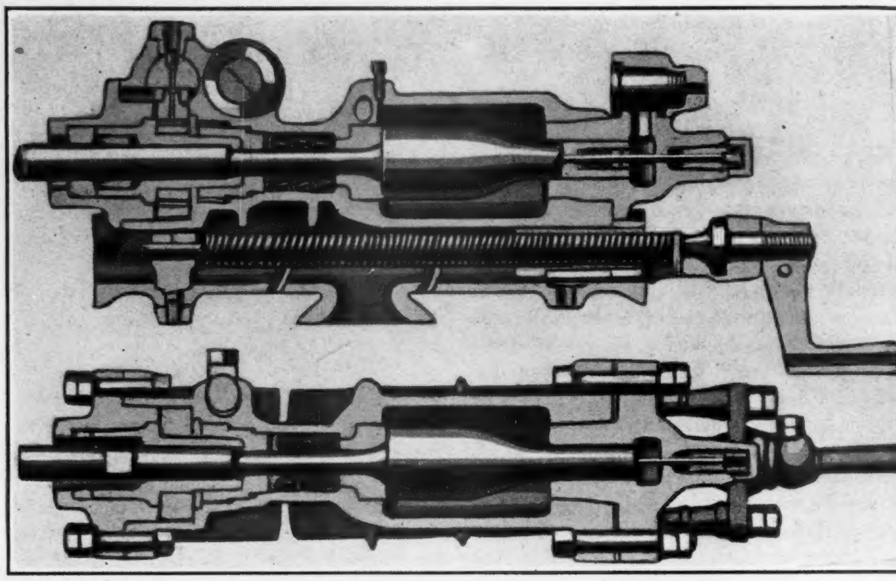


Fig. 2. The drill in section.

The Wave Power Rock Drill

The rock drill is shown in Fig. 2. It is similar in size and general appearance to the familiar air operated drill, but internally is entirely different. An important feature, which may be disposed of first, is that the rotation of the drill chuck is effected by an independent motor which cannot get out of synchronism with the hammer, both being operated by the same wave power impulses. The motor consists of a plunger working into a fluid "capacity" or chamber. The plunger actuates the rachet ring in engagement with pawls in the chuck.

A water flush is incorporated for washing the debris out of the hole. The water feed is controlled from the back end of the machine while the drill is working. A steel water tube passes through the hammer from the back end of the inlet piece and enters the hollow drill steel. A simple needle valve operated from the outside controls the amount of water passing through. The volume can be regulated to suit varying requirements without stopping the drill.

The hammer strikes direct on the end of the drill steel. The former, a floating piston, is a plain cylindrical forging of special alloy steel. It is in two parts, enabling the striking end to be renewed. A set of three packing rings surrounds the middle of the striking end of the hammer to take up any leakage past the front bearing. This set is adjustable without stopping the drill, being made from the outside by a square headed worm, in mesh with the screw gland. Suitable packings are also provided for the plunger of the ratchet, which are self-adjusting.

The operation of the drill is as follows: The waves of energy are admitted to the hammer element through the control cock which is situated in the inlet piece. These waves of energy act on the end of the hammer, throwing it forward until the front end strikes the drill shank. Surrounding the hammer is a chamber or space which is called a capacity. This capacity is completely filled with water and fulfils the function of a fluid spring. Due to the difference in diameter between the striking end of the hammer and the piston end, a displacement takes place on the forward stroke of the hammer which compresses the water in the capacity, so that on the pressure in the line dropping below mean pressure, the force acting on the annulus is greater than force on the piston end of the hammer, therefore the hammer is returned back to its original position to receive the next pressure wave. The capacity in conjunction with the hammer is designed to give the hammer a natural period of vibration equal to that of the generator, *i. e.*, 40 complete vibrations per second, or 2,400 blows per minute.

The Imperative Piping Requirements

The system obviously necessitates the providing of a pipe line very different from that in use with compressed air drills. It would simply laugh at any type of hose that might be suggested. Fig. 3 shows a "flexible" steel piping which has been patented for this service. It is called "Flexstel," and as will be seen the

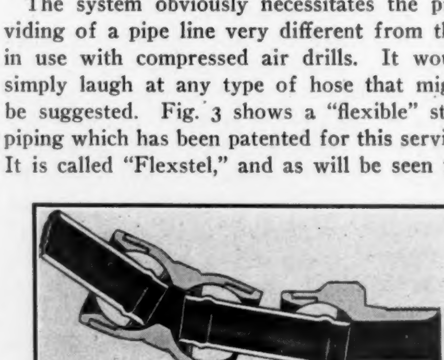


Fig. 3. Section of Flexstel piping.

individual sections are made from solid drawn steel tube with a spherical joint of novel type at the ends. The joint consists of a piece of steel formed with a spherical recess at each end, into which fits a length of solid drawn tube upon which is mounted the ball piece which accurately fits the spherical recess. This ball piece is flattened on one end to receive the special packing ring which is made from materials suitable for the special conditions to which the pipe will be subjected. A spherical seated nut is screwed into the double socket shoulders against the spherical surface of the ball piece and securely holds the pipe together.

It will be realized that the primary requirement at all times is that the pipe line, however temporary, shall be in length a multiple of half wave lengths. In ordinary installations, such as the rock drills here under consideration, the *mean* pressure is 750 pounds per square inch with a *maximum* of 1,500 pounds and all these joints to keep tight.

WATER FRICTION AND A BURNED HOSE

A STORY quite out of the ordinary, which states that the friction of water set fire to a hose, has started for a run through the papers. It is just a trifle too simple and requires a few more words to make it clearly understandable. The hose did catch fire, friction caused it, and water indirectly caused the friction as circumstantially told by Mr. J. S. Caldwell, chief engineer of the New England Insurance Exchange.

A single line of two and one-half inch double-jacketed, cotton, rubber-lined hose, to which was attached a deluge set with a one and three-fourth inch outlet, was connected to a 750-gallon automobile pumping engine which was maintaining 250 pounds pressure on the discharge gage when the gate on the pump was so throttled that the opening was only three-eighths or one-half inch. The throttling of the discharge produced a stream of very high velocity which impinged against the side of the hose just beyond the coupling. Such was the force of the jet that it caused a slight deflection of the hose at the point of impact and excessive vibration or fluttering of the hose. This fluttering or extension and recession of the deflection caused a rubbing of the jackets together and in two or three minutes the hose at this point became perceptibly warm and in five minutes was so warm that the hand could not be retained against it, which was followed by the distinct odor of heated rubber and the appearance of smoke. This was followed soon by the discoloration of the outer jacket as the cotton was carbonized. The fibers then commenced to fray and part and, as the outer jacket let go, it was observed that the inner jacket was carbonized in the same manner. The total time required to cause the charring and bursting of the hose was approximately fifteen minutes.

We learn from Charleston, West Virginia, that coal production of 27 of the largest producers in the State amounted to 25,583,663 tons in 1920, against 26,929,247 tons in 1919.

PNEUMATIC CONVEYING OF DUST IN CEMENT PLANTS

THE PROBLEM of handling materials in powdered form has been very successfully solved by the use of the so-called induction or air flotation system, which has been practically developed by the Clark Dust Collecting Company, 1116 Fisher Building, Chicago. It does away with all mechanical conveyors and allows no loss of material during the handling. It also renders the plant more sanitary and a more attractive place in which to work by making the spaces practically dustless.

The system consists principally of one or more collectors and a fan which exhausts the air from these collectors and filters the dust through the machines in such a manner that the exhaust is practically pure air. In what is called the 100% efficiency system, which is here illustrated, practically all the material is saved. Referring to the cut, the main air trunk, to which the various dust pipes are connected, enters the first collector known as the Clark adjustable air separator. This machine has several adjustments for regulating the quality or coarseness of the powder or dust, which is discharged from the flap trap valve at the bottom of the cone marked in the figure "coarse dust." One adjustment regulates the height of the inner cone in the collector, another adjustment regulates the admission of air to the bottom valve, and in this manner practically any percentage of coarse material can be obtained.

The finer dust which is carried into the top of the adjustable air separator is conveyed into the bottom of the Norbla suction filter, consisting of two or more cylinders. One of these cylinders is shown in cross section with the arrows indicating the currents of air traveling through the cloth filtering bags and out towards the eye of the fan. In this manner the finer dust is filtered through the bags and is dropped to the bottom of the filtering machine and taken away by the screw conveyor.

The cleaning of the bags is done by means of compressed air which operates a shaking mechanism, giving each bag a thorough mechanical cleaning, in addition to the reverse air current which is controlled by an auxiliary valve. This valve closes the main air passage and opens the cylinders to the atmosphere. In the cylinders which are under partial vacuum the admission of atmospheric pressure forces the air in the opposite direction from that indicated in the figure and completes the cleaning process. This is done every four or five minutes, the cleaning period lasting about four to five seconds. The time and duration of each cleaning is automatically regulated by a timing mechanism and the pressure carried is from 30 to 35 lbs. In many plants this pressure can be obtained by reducing from the compressed air line. In plants where there is no compressed air supply, this installation requires a small air compressor and air receiver.

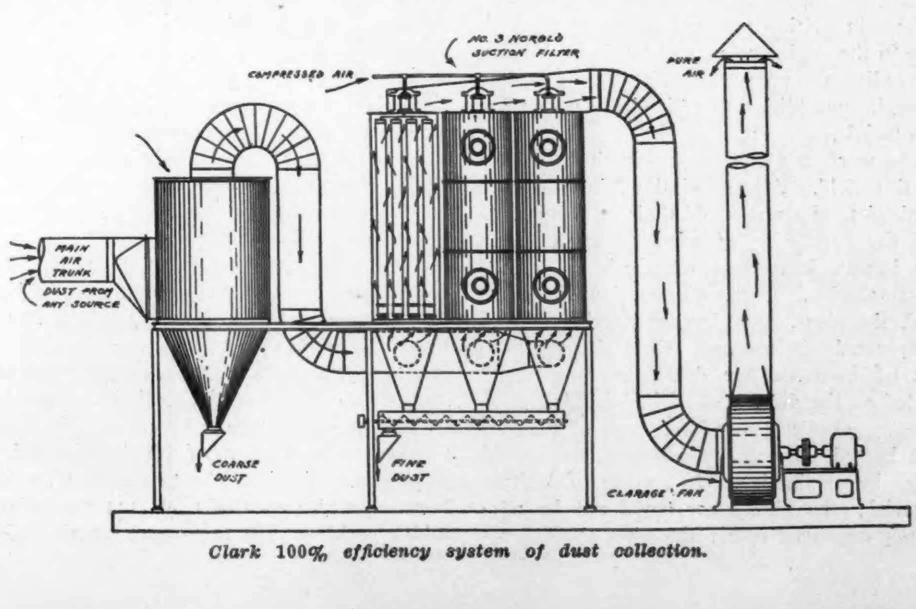
An interesting application of the same line of equipment has recently been developed by the Clark Dust Collecting Co. in connection with powdered coal, where the material is ground, and the fine dust resulting in the grinder is picked up from the expansion chamber, through a system very similar to the one outlined above.

These systems are a remarkable improvement in the line of air conveying, separating and dust collecting, where it is a question of handling material in powdered form, in a sanitary and efficient manner, and should be investigated by all progressive executives especially the cement industry.

AIRPLANES TO HUNT SMOKE

Further use of airplanes is to be made in the effort to solve the smoke problem at Salt Lake City. Among the theories advanced as to why coal smoke in the Salt Lake City area does not diffuse rapidly was that gases from nearby smelters formed into strata in the upper air, through which the coal smoke did not penetrate readily. Tests of the air above the city by airplane have produced no evidence to support that theory. Airplanes are now to be used to watch the effect of wind on fog and cloud banks in nearby valleys. The Bureau of Mines is coöperating in this work.

Messrs. Poillon & Poirier, mining engineers, have moved to 42 Broadway, New York, their former offices being at 63 Wall St.



Clark 100% efficiency system of dust collection.

Pressure Losses in Compressed Air Piping

An Interesting Comparative Study with Genuine and Substitute Packing Materials Made on a Holiday in a German Coal Mine—Difficulties of Obtaining Air in Quantities—Use of "Air Silos" Containing 280,000 Cubic Feet

[Translated for COMPRESSED AIR MAGAZINE from the engineer's report by H. Brinkmann, Vienna.]

THE QUESTION of compressed air economy has become, lately, of paramount interest in German coal mining. Compressed air is the carrier of energy in underground work; its working power is transmitted to the individual miner to the very spot where he handles his pickhammer, his cutting machine, his feeding chute, or his air winch. This close and immediate dependence by the miner on compressed air shows that it is almost unthinkable nowadays for him to work without this medium, hence the eagerness on the part of the board of management to be extremely alert to continually develop and improve on this silent servitor and to open up to it new fields of activity in order to derive a maximum profit from the very expensive man power through its best support and limiting human activity to mere attendance and guidance of compressed air work.

The possibilities in such equipment and the demand for compressed air have, therefore, continually grown and prompted those in charge to build "big" compressors. The piping, as regards diameter, has been adapted to the increased air quantity so as to avoid any possible decrease in pressure by overstepping the compressed air velocity admissible for each diameter. Attention has been paid to suitable and precise insertion of valves, bents and off-branches to avoid narrow spots. Furthermore, appliances have been inserted for compensation and removing of water. And in order to be able to dispose of sufficient compressed air, besides that in the piping, with enhanced consumption, so-called "air silos" of about 280,000 cu. ft. have been provided by availing themselves of cross-cuts for this purpose. Apart from these provisions, there has been a continually growing and developing plant supervision in the shape of exact piping scales testing the piping cross sections by means of automatic writing pressure gages at the surface in the engine room, and by the possibility of reading the pressures off the gages underground. In addition there is close supervision by officials.

The war put a stop to any further progress in this field. All technical appliances were strained to the utmost of their capacity without the possibility of adequate replacement, for human labor was extremely short and most valuable. Increased attention had to be paid, therefore, to a further development of compressed air economy, since the possibilities of increased air deliveries were scant. Added to the difficulties of building big compressors were the very long terms of delivery that barred the way. Operation itself could only be maintained by using substitute material; the piping net could not be adequately improved upon; the cross sections remained as they were, thus increasing the pressure losses. And to a great extent these latter were due to the fact that for packing, paper and similar substitute material had to be used; even the connecting hose consisted of substitute material thus adding to the difficulties encountered. At the same time the morale and discipline of the miners became weaker, the inspection possibilities became fewer and the shortage of meters, distracted the miners from paying proper attention to the gages.

The revolution and its sequence served by no means to improve the conditions. The miners were allowed shorter hours and their love of work sank to a minimum, and the industry ran the risk of irreparable damage, the more so since at the time there was no chance to build new compressors and the working material could not be renewed owing to lack of raw material. At this juncture the Board of Trade stepped in, appointed a commission and allowed a certain sum of money for a proper investigation. The first step taken was the placing of large orders for high-powered compressors; thus one mining company of the Ruhr district placed an order for ten big compressors amounting to about four million marks, or $60,000. So far only four of these compressors have been delivered in almost two years, and these deliveries took place as late as several months ago.

The foregoing shows that every attention is being paid to the most important causes for an insufficient supply. But the difficulties have not lessened as to an increase of air supply, or as regards installing new machines. The deliveries the shops require for turning out new machines are much too long. It is exactly the same to get new piping of a larger diameter; no alternative is left, therefore, but to do the best with the present means.

As is shown by the tabula hereunder, the engineers reckon with a loss of 30 per cent. caused by piping leakage. The test was taken on a holiday. The piping at a big pit installation, about 22 miles long, with a medium diameter of about five inches, was uniformly kept under a pressure of six atm., or about 84 lb., the total underground working being eliminated, including the nozzles, extra fans and pumps. For this purpose a compressor had to work continuously at 48 r.p.m. The compressor delivered 5,184 cu. ft. = 181,440 cu. ft. per hour, or 86.4 cu. ft. = 3,024 cu. ft. per minute. The consumption of the pit plant of free air amounts in the main shift time to 12,000 cbm = 420,000 cu. ft., so that the loss due to leakage during the principal working time amounts to 30 per cent. of the air delivered. A large part of this loss is to be attributed, as has been proved by repeated trials, to the substitute rubber packing. For these trials an air piping of nineteen meters (60′) length and 80 mm. (3″) dia., applying fifteen flange packings in an engine room so as to eliminate the variation of the day temperatures, was put together and kept under 84-pound pressure, when the air admission was shut off. The piping itself was absolutely tight. The inserted, automatically writing pressure gage took down during 24 hours the pressure conditions in the piping. For these tests, paper packing rings, paper packing rings soaked in linseed oil, and rubber packing rings were used, yielding the figures as shown in tables 1 to 3.

TABLE 1
Paper Packing Rings

Pressure (atm.)	Time (hours)	Decrease in pressure (atm.)	Minutes
6.0	10.30	—	—
5.5	10.45	0.5	15
5.0	10.54	1.0	24
4.5	11.08	1.5	38
4.0	11.30	2.0	60
3.5	11.54	2.5	84
3.0	12.15	3.0	105
2.5	1.00	3.5	150
2.0	2.00	4.0	210
1.5	4.00	4.5	330
1.0	8.00	5.0	570

TABLE 2
Paper packing rings soaked in linseed oil

Pressure (atm.)	Time (hours)	Decrease in pressure (atm.)	Minutes
6.0	12.22	—	—
5.5	12.38	0.5	16
5.0	12.52	1.0	30
4.5	1.10	1.5	48
4.0	1.30	2.0	68
3.5	2.00	2.5	98
3.0	2.30	3.0	128
2.5	3.15	3.5	173
2.0	4.15	4.0	233
1.5	5.45	4.5	323
1.0	9.00	5.0	570

TABLE 3
Rubber Packing Rings

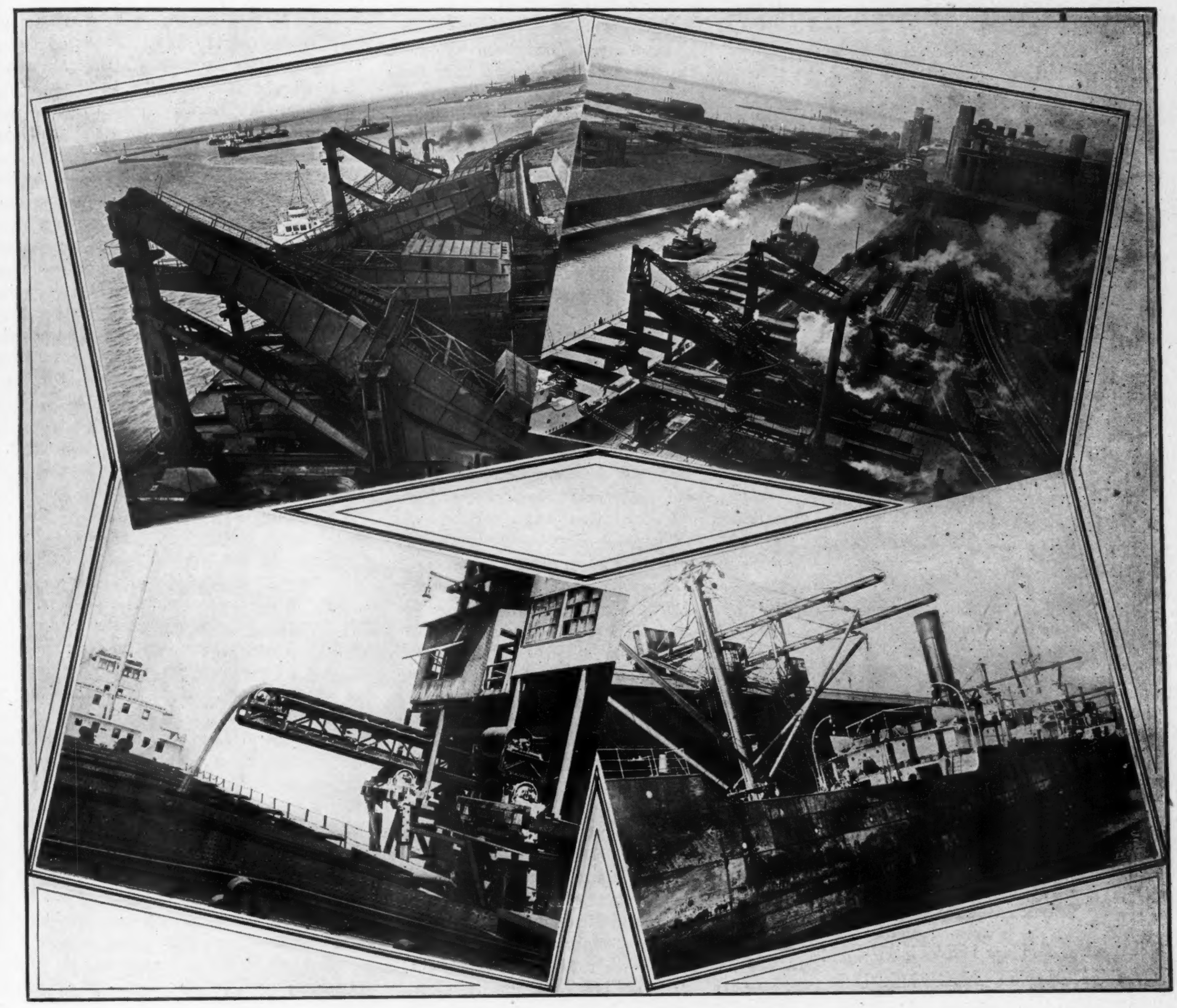
Pressure (atm.)	Time (hours)	Decrease in pressure (atm.)	Minutes
6.0	1.22	—	—
5.5	2.15	0.5	53
5.0	3.07	1.0	105
4.5	4.30	1.5	188
4.0	5.45	2.0	263
3.5	7.40	2.5	378
3.0	9.30	3.0	488
2.5	1.00	3.5	698
2.0	4.45	4.0	923
1.5	11.00	4.5	1298

TABLE 4

Hours	Paper packings (atm.)	Paper packings soaked in linseed oil (atm.)	(atm.)
0.5	4.8	5.0	5.75
1.0	4.0	4.5	5.4
1.5	3.5	3.8	5.2
2.0	2.8	3.2	4.9
2.5	2.5	2.8	4.75
3.0	2.25	2.5	4.5
3.5	2.0	2.25	4.3
4.0	1.9	2.0	4.2
4.5	1.8	1.8	4.0
5.0	1.7	1.7	3.8
5.5	1.5	1.6	3.75
6.0	1.45	1.5	3.6
6.5	1.4	1.4	3.5
7.0	1.3	1.3	3.4

The saving when rubber packings are applied is 700 cubic feet of air per minute. The loss with an hourly output of 420,000 cubic feet during the main shift time equalling 7,000 cubic feet per minute, is 892 cubic feet = 11.3 per cent. of the air when substitute packing rings are used and 2.6 per cent. loss with rubber packing rings.

Bulk Freight Handling on the Great Lakes and Atlantic Seaboard



SOME OF THE port facilities of America's Atlantic seaboard cities may be out of date, but the ports on the Great Lakes are up to the minute as far as modern piers and freight-handling machinery are concerned. A frequently heard criticism is that American seaboard piers and freight-handling machinery are, as a rule, old-fashioned. The comparison between fresh and salt water facilities comes of course as a sequence of the fact that up to the time of the European war America's deep-sea merchant marine was a negligible quantity in tonnage, whereas there was a very large tonnage of bulk freight carriers on the Great Lakes. On the great inland seas it had been necessary to provide modern piers and pier facilities for handling quantities of iron ore. So great a tonnage of iron ore must be produced and transported, involving loading and unloading, that every advantage is taken of mechanical aids. In the production of this tonnage, compressed air is used to operate Jackhamer drills, pneumatic tie tampers, air operated dumping devices for ore cars and for operating powerful plows or spreaders on the dump.

In the upper left-hand picture is a striking photograph of the huge ore hoists at Cleveland. These hoists take the ore from the hold of the ship and transfer it directly to railway cars on the pier for shipment to the blast furnaces. Each "scoop" picks up about seven tons of ore at a time. The hoists run on rails and can move from one end of a pier to the other. The upper right-hand view is from a picturesque photograph of Buffalo harbor and the great ore unloading yards and grain elevators. Buffalo is the principal eastern terminus of the lake freight carrying routes. Buffalo, like the other lake ports, will be greatly benefitted by the projected St. Lawrence deep-sea canal, which will open up the Great Lakes to ocean traffic.

In the lower left-hand photograph is to be seen a steamer loading ore at the head of Lake Superior. A Robins belt conveyor is spilling ore into the hold of the vessel in a steady stream. The lower right-hand picture shows some of the modern equipment that has recently been installed in New York harbor. These moving cranes for loading and unloading ships are fast and economical in action. Their use will gradually become universal at coast ports as shipping increases.

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EDITORIALS

SLUSHING, THE NEWEST IN UNDERGROUND TECHNIQUE

ATTENTION of our mining readers is especially directed to the leading article in this issue by Mr. LUCIEN EATON, Superintendent of Mines of the Cleveland Cliffs Iron Company, Ishpeming, Michigan, on the subject of the new slushing system of mining, which our most important authorities agree was the one great underground mining development of the last year. Mr. EATON has prepared for COMPRESSED AIR MAGAZINE the first noteworthy contribution to the subject that has appeared in the technical press, and his treatise will no doubt stand as a standard discussion of its advantages.

"Slushing," as it is called, consists, according to a timely definition in the *Iron Age*, in so arranging the raises conveying ore to the main drifts and in so conducting mining that ore is brought to the raises by scrapers worked by small hoists, employing but one man. These scrapers are attached by cables to the hoists, which are preferably drums with clutch throwing either one in or out. The hoist is attached to a timber, and the work may be facilitated by the addition of a boom swinging in as wide an arc as the space in which it operates permits. The hoists are usually air hoists, but electrically operated hoists may also be employed under certain conditions. Where this new system has been operated, hoists of two to three horsepower have been utilized, giving a rope speed of from 80 to 100 feet per minute, and having a load capacity or draw bar pull of from 1,000 to 1,500 pounds.

Mr. JAMES MACNAUGHTON, Vice-President and General Manager of the Calumet & Hecla Mining Company, Calumet, Michigan, declared recently in his published report on copper mining conditions in Michigan during 1920 (P. 164, Vol. 3, No. 4, *Eng. and Min. Journal*) that the most hopeful development in the way of saving labor and reducing costs had been in the use of mechanical scrapers for bringing the ore down the stopes into the tram cars. He went on to say that "mechanical loaders of various types have been experimented with for some years, and with varying degrees of success, but the weight and the initial cost were such as to make their extensive installation problematical, allowing for the most favorable development with use. The scraper seems to meet the problem nicely. It is easily transported from place to place, is simply rigged, requires no skill to operate, and makes possible as laborers a class physically incapable of the former work of the trammer."

Mr. MACNAUGHTON declared that the new slushing device was being installed as rapidly as possible in company mines where the dip of the lode required handling of the "rock" in the stopes. He added that when the copper market improved the normal output could be improved with "decidedly fewer trammers." The old type of trammer required physical qualifications such that the supply has been decidedly limited in recent years, and the big hope for the scraper, whether it reduces costs or not, lies in the widening of the field of available labor, Mr. MACNAUGHTON thinks.

We note in *Skilling's Mining Review* that the Calumet & Hecla Mining Company is constructing more mechanical scrapers in its shops and that as fast as they are completed they are being put at work in the conglomerate workings. Five scrapers have been employed in Nos. 6 and 7 shafts from the 72nd to the 75th levels. At the Mohawk mine, six stope scrapers are being used and others have been built to go into commission this spring. By this time, it was predicted, a level scraper will also be operating, so that if the market shows improvement Mohawk will be in a position to show a record tonnage. Wolverine mine is also preparing to use more scrapers, two having been in use on levels, with two more to go into stopes. A general observation is that these mechanical devices have contributed largely to the tonnage mined.

Mr. EATON's highly interesting article respecting the use of the scraper and other equipment in this new slushing system will clarify the whole subject for our readers and we commend to them its careful perusal.

FINANCING EXPORTS BY EDGE ACT CORPORATIONS

DURING THE period from the armistice to the first of the present year the manufacturers and exporters of the United States sold to foreign customers a vast amount of merchandise of all kinds. A very large percentage of this business was done on credit—short-term credit, for the banking facilities of this country were lacking in the machinery that would enable them to extend really long-term credits.

But the credits, so extended,—lack of banking laws notwithstanding—have proved to be anything but short-term; and notes, acceptances and bills in payment for goods sold abroad, many of them having already gone through several renewals, are still unpaid. It is estimated that these overdue obligations amount to the enormous sum of between three and four billion dollars and are being carried by manufacturers, producers and their banks.

"Frozen credits" they are called; and this vast sum of money, so congealed, is proving a serious hardship to those carrying it, as well as a menace to the proper functioning of domestic commercial transactions and banking generally. The greater part of this debt is, no doubt, good—in time—but its "frozen" condition renders it a disturbing factor, tieing up moneys that should be liquid in commerce.

Sensing this situation, the Congress, in the latter part of 1919, passed the "Edge Act," an amendment to the Federal Reserve Banking Act, especially designed to assist in financing foreign trade. Under its provisions and under the rulings of the Federal Reserve Board, Federal foreign banking corporations, as Edge Act companies are called, may elect to transact their foreign financing operations in one of two ways—no single corporation, however, can use both. They may, under the first method, elect to finance export and import business of their clients through the use of acceptances, and may, themselves, accept, buy, sell and otherwise trade in credit instruments of this character. Acceptance by one of these corporations constitutes a banker's acceptance and, in the hands of a member bank, is eligible for discount and rediscount at Federal Reserve banks.

By the second method such corporations may function through the issuance of their own debentures based upon long-term bonds, mortgages or other firm guarantees taken in trade from the client whom they undertake to finance, and for this purpose may, with the consent of the Federal Reserve Board, issue and sell such debentures to the public to the aggregate amount of ten times its paid up capital and surplus. All Federal foreign financing corporations are debarred from accepting and using as a part of their assets, the corporate stock of foreign companies. They are also debarred from doing domestic financing, from buying, selling and otherwise trading in merchandize or commodities of any kind, and they cannot accept moneys on deposit subject to check except as a necessary adjunct to a foreign transaction.

Although it may have been in the minds of

the legislators at Washington, when the Edge Act was passed that it might prove a warming pan by which some of the existing "frozen" credits might be thawed out, it appears that the corporations already formed and forming do not take this view. New business, they say, is their field and, unless conditions change materially, they propose to devote themselves strictly to keeping the financial temperature well above the freezing point in the future—leaving to the future and some-one-else to thaw out the ice: in other words, "George" will be expected to do it.

It has taken a considerable time for the business men of the United States to wake up to the fact that Congress had supplied a set of well-oiled machinery with which to operate the foreign trade finance mill, and it was not until last June, 1920, that the first corporation was formed under the Act. This is known as the First Federal Foreign Banking Association and its home is in New York. The doors of this corporation are now open for business and have been since the date mentioned, and it has elected to conduct its affairs by the acceptance method. The second, the Federal International Banking Company of New Orleans, opened its doors for business on February 9th, 1921, and has also elected the acceptance method for transacting its business—and will devote itself chiefly to financing cotton exports.

The only Edge corporation that has, so far, chosen to conduct its business on the debenture plan is the proposed big 100 million dollar company launched under the wing of the American Bankers' Association; the Foreign Trade Financing Corporation.

Any Edge banking company, whether operating under the acceptance or the debenture plan, is in a position to grant much longer credits to foreign customers than institutions operating under previously existing laws—credits that can, if necessary, be stretched out over a year's time or longer, thus enabling American exporters and manufacturers to compete on equal terms with those of Europe who, owing to their more favorable banking laws and their long familiarity with the needs of foreign trade, have long held the field.

Let us say, for example, that a manufacturer of rock drills has a prospective customer in Italy—a contractor, with a contract for building a line of railway and that he requires a large number of appurtenances to operate in excavations and tunnels. He wants a full year's credit, or more, for, in that time, he will have finished his contract and can "clean up." Granted, of course, that the contractor and the railway company with which he has contracted are sound and responsible. The manufacturer is not in a position to grant such long credits and the banks with which they do business demand a shorter term because their credits must be liquid. The contractor gets in touch with the Italian representative of the First Federal Foreign Banking Association and is told that arrangements can be made whereby he can buy the rock drills on credit and the financial operation so far as he is concerned is simple. The manufacturer will draw on him for the amount involved in the transaction. This draft he will accept, payable at the forward date stated on its face, and he is through with the matter till the due-date arrives. In the meantime the rock drills have been delivered to him. The Federal Bank Association will take the draft for collection and will hold it in its safe till maturity. In order to create liquid funds, however, with which to pay the manufacturer, the Banking Association will accept a draft that the manufacturer will make upon themselves. A banker's acceptance has thus been created which the Federal Banking Association will sell in the open market. Such an acceptance is discountable at any bank and is eligible for rediscount by a member bank with Federal Reserve banks within the 90 day period.

Transactions of this kind can be entered into at any time as the machinery for their operation is already installed in the banking association mentioned. In like manner, merchants, manufacturers and dealers in raw products may assist their foreign customers in obtaining credits for almost any reasonable length of time by obtaining acceptances of their drafts at forward dates, giving the purchaser time enough to sell his merchandise and "clean up."

SYNTHETIC AMMONIA BY THE CLAUDE PROCESS

IN OUR December issue the leading article, *Tapping the Atmosphere for Needful Nitrogen*, dealt with steps taken to offset the military disadvantage under which the United States labored when it was no longer practicable to obtain sufficient saltpeter from Chile. The article also brought out the part that an abundance of nitrogen plays in stimulating plant growth and thus increasing the quantity of foodstuffs to be harvested from a given area.

Only brief mention was made of the HABER process by which the Germans have found it possible to draw nitrogen from the air and then to combine it, under very high pressure, with hydrogen in producing gaseous ammonia, which, when acted upon by a suitable catalyzer, could be converted into nitric acid or nitrates. During the war, according to the figures available, the larger share of Germany's propellants and bursting charges were based upon nitrogen fixed by the HABER process; and it has been authoritatively declared that the Teutons intended to carry their work in this field of chemistry steadily forward after the cessation of strife so that they might be not only independent of the Chilean beds as a source of raw material, but actually able to compete in the markets of the world with nitrogenous products owing their origin to atmospheric nitrogen.

The devastated fields of Europe must, for years to come, be revitalized, again enriched with necessary quantities of potash, phosphorus, and nitrogen in order that they may bear in sufficient quantities to feed the debilitated millions of that part of the earth. As the French have seen it, they have imagined that their erstwhile arch enemy would profit by the situation to get a new grip upon them through the medium of fertilizers of German manufacture. In short, make the daily loaf the instrument by which to obtain both a vital and an economic advantage. But now comes the news that an eminent French physicist, Doctor GEORGES CLAUDE, has outstripped the cunning of Professor F. HABER by evolving radical improvements in the liquefaction of air and in the direct combination of nitrogen and hydrogen in generating ammonia synthetically.

According to the reports available, Doctor CLAUDE obtains his ammonia in the liquid form, and he realizes his ultimate product at an outlay far below that possible where the HABER cycle of operations is employed. The significance of this advance in the art is emphasized when it is recalled that the HABER process has been deemed hitherto extremely efficient, provided the needful technical supervision could be assured at a moderate wage. Highly trained attendants have been indispensable because it has been the practice to have recourse to pressures in the neighborhood of 2,700 pounds to the square inch and temperatures of a little less than 1,000 degrees Fahrenheit—factors that might contribute to a violent explosion if not watched ceaselessly.

Strange to say, Dr. CLAUDE has gone far beyond HABER in dependence upon great pressures, and it seems that he now subjects the combining gases to a pressure of fully 900 atmospheres! What is more amazing, the higher pressures are applied more economically in the end than much lower ones, which, at first blush, sounds like a paradox, keeping in mind the fact that added pressure generally means a larger expenditure of energy, which has to be paid for accordingly. The first stage of the work involves the liquefaction of air by the well-known CLAUDE equipment, after which the nitrogen is separated from the oxygen by a fractional distillation. The gaseous nitrogen is then mixed with a suitable proportion of hydrogen and compressed to 1,500 pounds to the square inch. The next step is to raise this compression to 3,000 pounds—using ordinary compressors for these two stages. In the third operation a new type of compressor is called into service which increases the pressure to 13,500 pounds—an achievement until now deemed feasible only on a reduced scale and in the laboratory.

This astonishing performance is made industrially practicable by taking advantage of a well-known fact, i. e., that the volume of the gas is diminished in proportion to the magnitude of the degree of compression. Therefore, Doctor CLAUDE has devised a small but extremely sturdy compressor capable of working safely at the maximum pressures desired; and for this reason the apparatus appears to be out of keeping with the spectacular character of its performance. We are informed that under the best conditions, the HABER process converts into ammonia only from ten to twelve per cent. of the gaseous nitrogen and hydrogen, while by CLAUDE's installation it is possible to get three times this measure of ammonia. Not only that, but it is announced that the ammonia is delivered directly in the liquid form—something that is not feasible by the HABER process.

Le Matin, in describing the CLAUDE inven-

tion recently, said that that eminent Frenchman, with his present modest plant, was able to produce daily a ton and a half of ammonia —the equivalent of seven tons of sulphate of ammonia. It seems that his equipment is only about one-thirtieth the size of a HABER installation of similar output. Superficially this would indicate a tremendous saving in first cost, quite apart from the notable gain in productive capacity. No wonder the French are congratulating themselves upon having outstripped that formidable rival, the Badische Anilin und Sodafabrik, of Ludwigshafen, which for years has dominated certain fields of chemistry in Europe and, for that matter, the world over.

To quote directly from a translation of *Le Matin's* article: "It is not in the form of sulphate, but as chloride of ammonia, that Monsieur CLAUDE intends to furnish our farmers with the fertilizer they need. This will permit the use of chlorine which is now a by-product, in large quantities, in the manufacture of soda. This will promote the union of two essential industries, and make for an industrial solidarity of the utmost importance to the commercial well-being of France."

In short, it is confidently prophesied that with the potash deposits in Alsace and Doctor CLAUDE'S invention French tillers of the soil need not look beyond their own boundaries for a sufficiency of plant food; and there are those that believe that France may even be able to invade the fertilizer markets heretofore controlled by Germany.

In bringing about his radical improvement in the synthetic production of ammonia, CLAUDE is using mechanical agencies of his devising which incidentally yield, at one stage in the cycle, large measures of liquefied oxygen in a state of comparative purity. This stuff may prove of conspicuous use in mining as a substitute for the usual explosives employed. This technical problem engrossed especially the attention of the Germans throughout the period of the Great War when both glycerine and nitrates were at a premium among the Central Powers. The Teutons resorted extensively to liquid oxygen as a blasting charge in many of their mining operations, and even used the material for destructive purposes in wrecking factories which they had to abandon under the pressure of the Allies' advance. Our article elsewhere in this issue discusses this widened adaptation of liquid oxygen.

INFERIOR MOVIES MENACE INDUSTRIAL WORKERS

MILLIONS of industrial workers who find their principal amusement in visiting moving picture theatres in leisure hours of the evening, will perhaps agree with M. HENRI BATAILLE, one of the most popular of living French playwrights, that the cinematograph of the present "is the greatest enemy of thought and progress." This is not the fault of the moving picture art itself, which he thinks may become admirable in possibly half a century, but is due to producers who speculate upon the lowest qualities of humanity. The dramatist declares that the producers of pictures are not sincere, and that there can be no art of course without sincerity. Even the resignation of the public to a low standard of pictures is not sincere. The public admits that the "celluloid drama" is mainly bad, but keep on going to see highly inferior productions, meantime merely hoping the cinema will get better without voicing any effective protests that exhibitors would be forced to pass on to producers.

M. HENRI BERNSTEIN was asked whether he thought motion pictures would ruin the theatre and replied that photography had not killed the art of painting. He refused to predict what the cinema would do to the theatre, but he had little hope for it at present, since it had developed little real art. Notable authors worked for the screen now merely to make money.

The moving picture situation is a pity in America, where the "best" pictures admittedly are produced. A greater proportion of the public are devotees of the silver screen in America than in other countries. The opportunities for presenting a large measure of educational and industrial films, travel pictures and wholesome dramas of real merit are almost unlimited, but the producers apparently prefer to cater or pander to vulgar and low instincts. Instead of stimulating productive thought and social betterments, present-day pictures make for envy, dissatisfaction, mental and physical stagnation, and even incite crime. Chicago has had to bar all crime pictures from her theatres because they were found to be creating young criminals.

The opportunity for the moving picture is enormous. Its present estate would seem to call for intelligent national legislation, and for widespread public protests.

THAT $5,000 PRIZE FOR EXPLAINING EINSTEIN

DOCTOR EINSTEIN still has our tiny and inconsequential earth by the ears with his theory of relativity. It is tremendously interesting, but the great trouble is that the vast majority of folk, including those who have enjoyed "higher education," cannot comprehend it—or rather cannot encompass with their minds obvious deductions from the EINSTEIN theory, such as the setting of a limit on the dimensions of the Universe. Our neighbor, the *Scientific American*, which aims to be practical, arranged a prize contest, by means of which the most lucid essay of explanation of the EINSTEIN theory for the benefit of the lowly layman, should receive $5,000 offered by Mr. EUGENE HIGGINS of Paris, an amateur enthusiast in physics and mathematics.

Mr. L. BOLTON, of London, who is a member of the staff of the British Patent Office, has received the award of this substantial prize for clear thinking and clarity of expression, having won over the heads of distinguished and better-known competitors such as Dr. WILLIAM H. PICKERING of the Jamaica Observatory of Harvard University, Dr. HENRY NORRIS RUSSELL of Princeton University, the winner of the Royal Astronomical Society's Medal for his work in 1920; Dr. WILLIAM DE SITTER, the Dutch astronomer; Doctor SCHLICK, who wrote *Space and Time in Contemporary Physics*, and Dr. H. H. TURNER of Oxford University.

Comparatively unknown outside his immediate circle in London, Mr. BOLTON has now achieved fame and recognition because of the successful outcome of his rivalry with well known English and American physicists. In connection with the fact that he is connected with the British Patent Office, it is noteworthy that Doctor EINSTEIN himself once held a similar post in the Swiss Patent Office.

In his prize essay Mr. BOLTON enunciates the mechanical principles of relativity, and also the special or restrictive principle of relativity, which is credited to Prof. ALBERT A. MICHELSON, of Chicago, recently announced discoverer of a method of measuring the mass of fixed stars, such as the now quite celebrated Betelgeuse of the Orion constellation. We quote this principle to be that "by no experiment conducted on his own system can an observer detect the unaccelerated motion of his system," and, secondly, "the measure of the velocity of light in vacuo is unaffected by relative motion between the observer and the source of light."

Attention is called by the New York *Times* to the fact that the first is explained by the familiar illustration of a passenger in a slowly moving train. He cannot tell at first whether the one he is sitting in, or an adjacent one, is moving; he has to wait for bumps or the sight of some object he knows to be fixed. And the second is likened to waves in water, started by a ship, which move of their own velocity.

"So waves in space," explains Mr. BOLTON, "travel onward with a speed bearing no relation to that of the body which originated them."

The first deduction from an examination of the laws of relativity, the prize essayist says, is that "lengths and times have not the absolute character formerly attributed to them. As they present themselves to us they are relations between the object and the observer which change as their motion relative to him changes. Time can no longer be regarded as something independent of position and motion, and the question is what is the reality?

"The only possible answer is that objects must be regarded as existing in four dimensions, three of these being the ordinary ones of length, breadth and thickness, and the fourth, time. The term 'space' is applicable only by analogy to such a region; it has been called a 'continuum,' and the analogue of a point in ordinary three-dimensional space has been appropriately called an 'event.'"

Mankind does not possess the requisite faculties to form a mental picture of a "continuum," Mr. BOLTON asserts, but the symbols of a mathematician enable him to extract the relative properties from it and to express them in a form for exact treatment. It is difficult to form a general law to hold good for all observers whose systems may be moving at different rates, because accelerations imply forces which upset the formulation of any general dynamical principle.

"The following example taken from EINSTEIN will make this clear, and also indicate a way out of the difficulty," writes Mr. BOLTON. "A rotating system is chosen, but since rotation is only a particular case of acceleration, it will serve as an example of the method of treating accelerated systems generally.

"Let us note the experiences of an observer on a rotating disk, which is isolated so that the observer has no direct means of perceiving the rotation. He will, therefore, refer all the occurrences on the disc to a frame of reference fixed with respect to it and partaking of its motion.

"He will notice, as he walks about on the disk, that he himself and all the objects on it, whatever their constitution or state, are acted upon by a force directed away from a certain point upon it, and increasing with the distance from the point. This point is actually the centre of rotation, though the observer does not recognize it as such. The space on the disk, in fact, presents the characteristic properties of a gravitational field.

"The force differs from gravity, as we know it, by the fact that it is directed away from instead of toward a centre, and it obeys a different law of distance, but this does not affect the characteristic properties that it acts on all bodies alike, and cannot be screened from one body by the interposition of another. An observer aware of the rotation of the disk would say that the force was centrifugal force —that is, the force due to inertia which a body always exerts when it is accelerated."

Mr. BOLTON probably conservatively states a truth when he declares that "mankind does not possess the requisite faculties to form a mental picture of a 'continuum,'" even though he be gifted as a mathematician.

NEW STOPING RECORD ON THE RAND

At the Geduld Proprietary Mines, on the Rand, South Africa, a miner, L. H. Ellitson, established what is claimed to be a new world's stoping record when in the month of November, 1920, he broke 215 fathoms of rock, the previous world's record having been 190 fathoms. Three No. 18 Ingersoll-Leyner drills were used, the fathoms per machine shift being 2.56, and 40 tons being broken per machine shift. The stoping width was 63 inches. In the three months preceding November the same miner broke 185, 185½ and 190 fathoms, respectively, with the same machine. According to the Union Corporation, Ltd., which operates the Geduld mine in which the record was made, the Leyner stoping in this mine averaged 1.7 fathoms per machine shift for 1920 for 38 machines running.

The advance in the price of silver increased the actual worth of British coins to a value higher than that shown by their face, until $1.81 worth of the metal was required to produce $1.34 worth of currency. To remedy this condition a new coinage has been issued in which the silver content is reduced to 500 parts from the 925 parts formerly required by the substitution of a large percentage of nickel. The new coins weigh about as much as the old.

TRAINING INDUSTRIAL WORKERS, A thorough treatment of the methods of adequate and effective employee education by ROY WILLMARTH KELLY, Manager of Industrial Relations for the Associated Oil Company of California; Specialist in Vocational Training and Plant Surveys for the Pacific Coast Bureau of Employment Research; Sometime Director of the Harvard Bureau of Vocational Guidance. Price $5.00; 437 pp.; New York: The Ronald Press Company.

ANY CONSTRUCTIVE labor policy must go back into the question of education. This manual describes the work and possibilities of technical and secondary schools and classes, State and Federal aids to vocational education, and the work that can be accomplished within the plant. It shows how to establish a training system, discusses apprenticeship problems, and outlines plans of training for workers, foremen, and minor executives. It explains organizing transfers and promotions, rating employees, and meeting the modern trend in industrial education. Representative training plans, a complete survey of the work and methods of industrial training, and an extended bibliography are included.

This book is one of three Ronald manuals which, together, give a comprehensive, unified presentation of the three aspects of labor management: securing workers, training them, and holding them by maintaining satisfactory working conditions.

TRADE ASSOCIATIONS. Their Organization and Management by EMMETT HAY NAYLOR, President, American Trade Association Executives; Secretary-Treasurer of the Book Paper, Cover Paper, Tissue Paper and Writing Paper Associations. Price, $5.00; 389 pages; New York: The Ronald Press Company.

THIS BOOK is a detailed analysis of the typical trade association. Its thorough description of working methods makes it of special importance to association officers and members, as well as to those who are contemplating the organization of an association. Writing from the inside, the author unequivocally opposes dishonest practices and provides valuable material for thought for those who are interested in the trend of trade development. The author shows why such organizations as boards of trade and chambers of commerce are not trade associations. He gives a brief but exceedingly interesting description of the evolution of the trade association and discusses fundamental points of theory, including co-operation and competition, fair prices, and the law relating to associations. The book covers association routine, and explains the conduct of meetings, the commercial and industrial functions of the association, and its informative and protective service activities. An association cost system is instructively discussed, and inasmuch as the success of a trade association depends largely upon its choice of the right man for secretary, two important chapters deal with his qualifications and duties. The book also contains a number of representative charts and forms, an exceptionally complete bibliography, and the most accurate list of associations, with addresses, ever published.

This exceptionally clear and readable volume is the outgrowth of several years' study in connection with the author's work for his own associations. It is not only the first authoritative description of a trade association, but is also a vigorous plea for the utility of the trade association as an agency for effective and honorable business.

THE HOUSING FAMINE, How to End It—A Triangular Debate between JOHN J. MURPHY, EDITH ELMER WOOD and FREDERICK L. ACKERMAN. Price, $2.50. New York: Messrs. E. P. Dutton & Co.

HERE WE HAVE a written debate by three experts, presenting their views on how to remedy existing house conditions in the United States. It is doubtful, as Mr. Murphy says, whether there is any question of equal fundamental importance now confronting the American public. The shortage of housing quarters for city dwellers, for industrial artisans in smaller communities, the lack of choice in domiciles which has led to outrageous rent profiteering on the part of a large percentage of landlords who have no scruples in exacting all and more than the traffic will bear, has probably been the most acute manifestation of the social disorganization due to the war which has yet appeared in America.

It is equally true that the depreciation of housing standards, subtly operating, is diminishing the self-respect of thousands. The whole situation is giving rise to the question, "How far shall the State be called upon to attempt to supplement the shortcomings of a faulty social system?" Something on a proper scale and scope should be done, without doubt. Many landlords are pillaging their tenants. Building contractors in many localities are pillaging purchasers of houses, and the contractors are being pillaged in turn by the dealers in materials. It has all been a wretched and sordid story, no matter what may be the attempts to gloss it over. The revelations of the public inquiry in New York City, placing organized labor in the buildings trades in such an unenviable light through the machinations of a Brindell, are only a phase of it.

An acquaintance, driven to desperation by the doubling of his already high rent in New York City, decided to purchase a house in Long Island. He looked over an alleged "bungalow" and while he rebelled at the price, decided it was the lesser of two evils as a personal financial matter, and decided to buy. He moved his effects to the new house, including a grand piano. The piano was moved into the principal living room—and went through the floor!

Individual corporations here and there have undertaken highly praiseworthy housing developments for the benefit of their industrial employes, but the great mass of people in the United States is still at the mercy of conditions for which natural war causes are in part responsible, but which are aggravated by unpitying greed, especially in New York.

Our population has grown during a period of years when building operations ceased as a corollary of our war efforts. To make the matter worse very large numbers of rural dwellers went to the cities to live to obtain the higher war time wages that were available. A large percentage of these are not going back to the farms and small-town industries, but are remaining in the cities, already overcrowded by normal increases in population. In the last year we have had a considerable influx of foreign immigrants also.

The debaters in the book we have at hand present supremely important views on this subject of such solemn importance. Next to food the most vitally important thing in life is a home, be it ever so humble. With regard to the matter of governmental aid, it is noteworthy that many who have resented interference by the State in individual life are assuming an attitude of tolerance toward this particular manifestation of it. If the problem is not soon solved otherwise, this sentiment, Mr. Murphy believes, must grow, for people must have housing accommodations.

In the limits of this page we cannot give the space requisite to an adequate setting forth of the views of the Murphy-Wood-Ackerman debaters, unfortunately. The debate was arranged by and held under the auspices of the Press Debates Association. The thesis for the written debate held that "Industry, commerce, agriculture, government, the whole machinery of civilization, are not ends in themselves, but means to the great human end—the creation and maintenance of a healthful, happy home." The United States is short 1,000,000 homes today. It has 2,000,000 other homes that are far below standard and which ought to be scrapped, were it not for the present famine.

It is of course a world problem, as well as a national one. Part of Mr. Ackerman's solution is revolutionary since it involves freeing the processes of industrial production from that control which views production as a legitimate medium of speculation or investment for profit. He also believes in freeing land from speculative use, and in "eliminating waste and useless effort which follows the present system of price competition." Mr. Ackerman thinks the housing famine is not the result of the war, so far as America is concerned. We believe no intelligent reader can agree with him.

Mr. Murphy seems more credible, although he excuses landlords in a measure because they are merely human in the face of opportunity to gouge; of course, all landlords cannot be lumped together either, for there are some of them no doubt that have hearts. Both Mr. Murphy and Mrs. Wood indict the public for seeming apathy on the subject, but in New York, for instance, what else is to be expected of a public that has watched the doings at Albany?

Mr. Murphy finds that in the present emergency we must resort to alleviations; self-reliance has solved our problems in the past; it will solve this one if we use our brains. Mrs. Wood decides that the American people, and we believe her right in this, are neither radicals nor reactionaries. They stand for orderly progress and a square deal for all. Therefore, to her idea, the housing of the lower paid wage earners should be removed from the domain of business enterprise, which does not want it, and taken over by the state as a public utility. Mr. Ackerman is quite frankly radical and doesn't agree with Mr. Murphy and Mrs. Wood in many particulars. His own purpose is to discover the cause before suggesting a remedy and he says that "how to end it" hangs on the attitude toward profit.

In reading this interesting debate, one will find much interesting and helpful material, even though he does not agree with all of the conclusions.

AN ODE TO COMPRESSED AIR

By Edward Thompson

MINE IS the strength of a mighty army;
MY POWER is infinite, absolute, and irresistible.
I KNOW no limitations save those imposed by human invention.
MY POTENTIALITIES are of immeasurable magnitude.
I BUILD, destroy, and build again.
MINE IS the force that makes Earth's vitals tremble,
AND FOLLOWS in each process known to man
THAT BUILDS and molds and forms a nation,
PROVIDING shelter, sustenance, and even life.
MY INFLUENCE extends to the end of the earth,
TO THE towering heights of the firmament,
AND THE nethermost parts of the sea.
WITHOUT MY aid industry is as a crippled soul.
I AM ingenious, comprehensive and resourceful,
CREATIVE, submissive, enduring.
I AM at once the servant and master of mankind
I AM *COMPRESSED AIR.*

The oil resources of Slovakia are declared to be without doubt one of the great assets of the Czecho-Slovak State. There are three basins, situated far apart, where oil is either flowing or is being prospected for.

In a Government (British) building of no great age it was observed recently that the electric bells had become very uncertain in action. Various causes were suspected, and at length it was surmised that the defect might be due to mice. This proved to be the case, the insulation of the wires being gnawed away by the vermin. The premises were treated thoroughly with barium carbonate, and since then no further interruption of communications has been reported.

The United States Steel Corporation has issued Bulletin No. 8, describing in great detail the work of its Bureau of Safety, Sanitation and Welfare. No company that has a welfare department, or that is interested in the welfare of its workers, and what company today can fail to be, should neglect the matter of procuring a copy of this booklet. Every welfare director in the country should read it and inspect the pictures it contains, from start to finish. In less than nine years the steel corporation has expended more than $81,000,000 on welfare work, relief, pensions and for like purposes.

NEW MINING PUBLICATIONS

THE BUREAU OF MINES of the Department of the Interior has published the following new bulletins and technical papers.

BULLETIN 191. Quality of gasoline marketed in the United States, by H. H. Hill and E. W. Dean. 1921. 270 pp., 22 figs.

TECHNICAL PAPERS

TECHNICAL PAPER 251. Ventilation in metal mines, a preliminary report, by Daniel Harrington. 1921. 44 pp.

TECHNICAL PAPER 255. Chlorination of natural gas, by G. W. Jones, V. C. Allison, and M. H. Meighan. 1921. 44 pp., 9 figs.

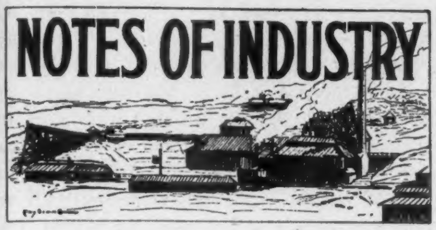
TECHNICAL PAPER 275. Quarry accidents in the United States during the calendar year 1919, by W. W. Adams. 1921. 66 pp.

NOTE.—Only a limited supply of these publications is available for free distribution and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

PHYSICAL PROPERTIES OF MATERIALS

CIRCULAR NO. 101 of the U. S. Bureau of Standards is devoted to the above topic. The compilation of the data has been going on for some time, and before the circular was thought of. The tables compiled were first issued to a limited number of Government establishments in mimeographed form.

The circular aims to present in readily accessible form the best available data on the strength and related properties of materials. Among those treated are iron, carbon steel, alloy steels, wire and wire rope, semi-steel, aluminum, copper, miscellaneous metals and other alloys, rope, rubber, leather and wood. The tensile strength, proportional limit, percentage elongation in two inches, percentage reduction of area, Brinell and scleroscope hardness corresponding to a certain composition, density, and method of preparation are shown in most cases for the metals and alloys. In addition, figures are given in many instances for the compressive and shearing strengths, moduli of rupture, and Erichsen values.



The National Research Council of the United States has established a Research Information Service for supplying information concerning research problems, progress, laboratories, equipment, publications, funds, and so on. It is intended to act as a clearing house for industrial and scientific research matters. The service is normally without charge. The secretary's address is 1701, Massachusetts avenue, Washington, D. C.

Several engineering firms in Germany now specialize in small, light compressed air "pistols," suitable for a variety of purposes, including cleaning of castings, etc., in which case they are usually of $^{3}/_{32}$-in. bore. They can be operated direct from compressed air mains carrying pressures up to 215 lb. per square inch. The weight is from 9¾ oz. upwards.

Radium is, almost beyond comparison, the most valuable element in the world. One gramme of radium, which is about a thimbleful, costs $120,000, as opposed to $150 for an ounce of platinum. So powerful is it when mixed with other materials that even a minute particle is effective in making surfaces self-luminous for years. It is this quality which makes radium-luminous material commercially possible. The great value of radium is due to its scarcity, and to the great difficulty in isolating it after it has been found. Much of the radium of the world now comes from the carnotite ores of the United States. A great portion of this comes from the Undark radium mines in the Parado valley of Colorado. The ore is found in narrow seams. It is transported 60 miles on the backs of burros and mules and then by rail to Orange, N. J. One gramme of radium is derived from 250 tons of ore.

A giant eye-magnet for the removal of fragments of metal from injured eyes has been installed in the operating theatre of Preston Royal Infirmary. The instrument was designed by Mr. J. F. Simpson, tramway engineer, with the assistance of Mr. G. J. Gibbs, consulting electrical engineer. The cost has been defrayed by workmen engaged in the metal trades of the district.

The recently established Credit Institution for Polish Industry, which is now operating, is said to be considering an issue of bonds payable in foreign currency and guaranteed up to £20,000,000 by the Polish Government. The idea is to issue bonds to manufacturers desiring to import raw materials against the security of their buildings, plant and machinery, which will be assessed at pre-war value. Loans, however, are not to exceed 50 per cent. of the value of the buildings and 25 per cent. of the value of plants. Bonds, according to the plan, are to be amortized over a ten to 25-year period at seven per cent., and are to be approved by the credits committee of the League of Nations.

Mr. T. G. Trevor, Inspector of Mines, Pretoria, thus emphasizes the industrial importance of sulphur. "In the chemical industry everything depends somewhere in the history of its manufacture on the use of sulphur, mainly in the form of sulphuric acid. The paper on which this article is printed would not be white without its use. Without its use no explosives are made. One is lucky if the white wine on one's dinner table and the blacking on one's boots are free from it, for some of the ingredients used in their preparation have probably also been manufactured by its help."

Great interest has been evinced both in Germany and in America over reported negotiations between the United States Mail Steamship Company, an American line, and German shipyards for the refitting of the fifteen passenger steamships allocated by the United States Government to the company. The estimated cost of this repair work is $25,000,000 and placing it in Germany would go far toward reëstablishing that country's shipyards. The U. S. Mail line has a contract with the North German Lloyd line, through which it has the use of the latter's terminals and offices, and this fact is said to have had an influence upon the matter of placing the repair work in the hands of German shipwrights, following conferences between officials of the two lines. Among the big liners formerly belonging to Germany, and now allocated to the American company, are the *George Washington,* the *Mount Vernon,* the *Agamemnon,* the *America* and the *President Grant,* which vessels have been lying in American yards.

The Bureau of Standards at Washington issued in its *Technical News Bulletin* of January 7 the following reports of interest to engineers, chemists and shop men: Performance of Starting and Lighting batteries; Gas Appliance Design; Standards for Gas Service; Year's Progress in Radio Telephony; Hardness of Steels Produced by Abrasion; Carbonization of Lubricating Oils; Recent Publication on Paints; Definitions and Specifications of Lime.

Europe

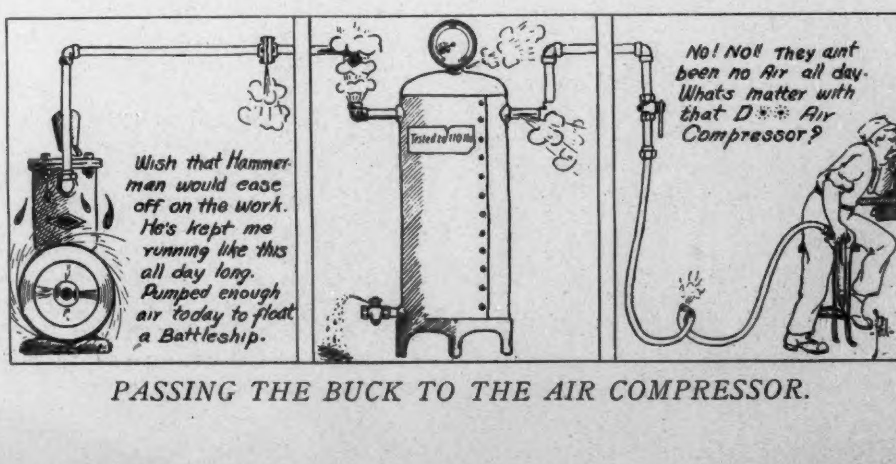
Two new factories have been started in Poland to provide rolling stock for the railroads. The Polish government is reported to have ordered the building of 1,200 locomotives to be delivered over a ten-year period, beginning with this year.

A new alloy of copper and aluminum has been invested and tested by Aktiebolaget Skandinaviska Armaturfabriken, of Stockholm. The name given to the new combination is "alco bronze." It has the color and lustre of gold, and it is said to be stronger, tougher and harder than any other bronze. It can be wrought, forged or rolled in any way without suffering deterioration, and it resists the influence of the air, acids and salt water, being therefore particularly suitable for ships' forgings, propellers, condensers, machine parts, bearings, surgical instruments, skates, ornaments, etc.

The Società Idroelettrica Cisalpina, of Milan, founded in March, 1919, with a capital of 2,000,000 lire paid, has decided to increase its capital to 30,000,000 lire for the purpose of carrying out a projected hydro-electric plant in the Liro Valley, Valtellina.

Belgium and Holland are emulating American methods of modern shipyard construction. So, also, are the structural engineering industries in these countries and in France. Self-contained portable plants, once considered necessary, are being scrapped, and compressed air installations, always within easy reach of the workmen no matter what their location, are being substituted, slowly but surely. Devices using compressed air energy are being placed on the market for these trades and the first results noted are increased production and smaller manufacturing costs.

The heaviest timbers are oak, teak, jarrah (an Australian wood) and greenheart; the lightest are willow, poplar and spruce. The difference is enormous. A cubic foot of teak will weigh more than 80 pounds, while a cubic foot of willow does not exceed thirteen pounds. Besides being one of the heaviest, the African teak oak is also the strongest of all woods.

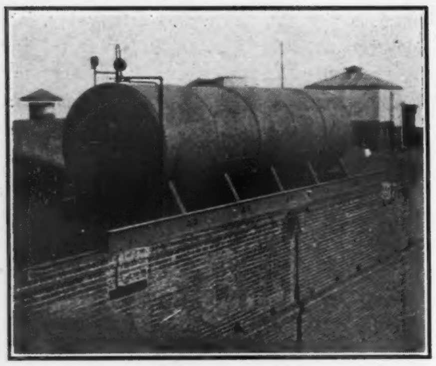


PASSING THE BUCK TO THE AIR COMPRESSOR.

FIRE PROTECTION AT SAN FRANCISCO WAREHOUSE

THE HASLETT Warehouse Company at San Francisco has installed three 7,500 gallon steel tanks on the roof of one of their warehouses, each tank being under an air pressure of 80 lbs. The pressure is kept up by a compressor operating at 500 R.P.M. The compressor is direct connected to a 15-h.p. electric motor.

A sensitive electric alarm is connected with each water tank and adjusted so that when the air pressure falls below 60 lbs. or rises above 85 lbs. an alarm is turned into the American district telegraph office, which in turn calls the fire department, and in less than five minutes the fire department equipment will arrive at the warehouse.



One of the 7,500 gal. water tanks, with pressure gage and electric alarm.

The compressor and motor together with a water pump are housed in a special galvanized iron house on the roof of the warehouse. The engineer of the warehouse makes a daily inspection of equipment, to ascertain that it is in perfect condition. The same motor that operates the air compressor also operates the pump that supplies water to the 7,500 gallon tanks. A 25,000 gallon gravity water tank is connected with the three 7,500 gallon tanks in such a manner that when the water is exhausted in the pressure tanks the gravity tank will automatically become effective.

According to *Die Kalte Industrie,* considerable success has attended the use of liquid air for coal-blasting purposes at the Kladno coal mines of the Buschtehrader Railway. It was introduced in 1916, and until the company had its own air-liquefying apparatus the air was supplied by the Eager Maschinenfabrik in double-walled holders of 6 gals. capacity, delivered to the mines by express trains, where it was, according to requirements, filled into smaller vessels of one gal. capacity, in which it was conveyed to the working faces. The cartridges were made of linen cloth bottles filled with naphthalin soot, 12-in. and 6-in. long and 1½-in. diameter, preliminarily cooled in a little liquid air, and then soaked for five minutes.

The 5-pfennig German coins are now made of iron; the 10-pfennig, of zinc; and the 50-pfennig, of aluminum.

RIGHT KIND OF FOREMEN'S COURSES

American business is finding it profitable to train plant foremen in the elements of good foremanship. Courses of instruction, conducted in the plants and designed to train foremen to cope with the problems that present themselves each working day, not only are developing better foremen, but are bringing returns in the form of increased morale, lower labor turnover, reduced costs and greater production.

The purpose of foremanship training, says an authority on the subject in *Forbes Magazine* (N. Y.), is to increase production and decrease costs. It is easily understood that those two things naturally follow when foremen are developed into real leaders and manhandlers, thoroughly conversant and proficient in all phases of their jobs. A well-organized course, therefore, will have these general functions:

1. To view the foremanship job in the perspective.
2. To analyze its responsibilities.
3. To develop intelligent performance of these responsibilities.
4. To develop team work.
5. To develop correct interpretation of policies.
6. To develop constructive thinking.
7. To develop analytical ability.
8. To develop leadership and subordinate driving methods.

The course itself he adds, must be planned specifically around the first four items. The rest is more or less the general result of the discussions and follow up. Any foremanship course that performs these functions, even to a limited degree, is serving its purpose.

MINUTE MERCHANDISING

As a result of an appropriation of $225,000 by the New York legislature, the largest single transaction in radium merchandising was effected by the state's purchase of 2¼ grams of this element from the Radium Luminous Materials Corporation, for the Institute for Malignant Diseases at Buffalo, to be used for cancer research.

The sale of 2¼ grams (.08 ounce) of radium is notable in that it is the first transaction the extent of which arises above the milligram level. In response to the state's advertisement, bids were submitted by the Standard Chemical Co., of Pittsburgh, Pa; the Radium Co., of Colorado, Inc., 50 Union Square, New York; Corning & Co., Albany, N. Y., and the Radium Luminous Materials Corporation, 58 Pine street, New York.

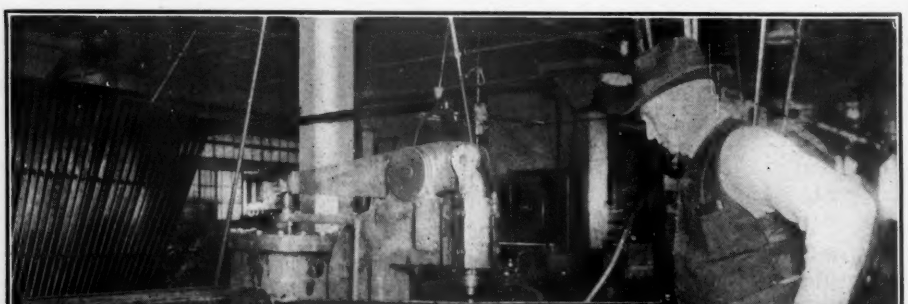
COMBINATION PNEUMATIC PUNCH AND RIVETER

WE REPRODUCE herewith a new machine manufactured by the Baird Pneumatic Tool Company, of Kansas City, Mo., which can be used either as a punch or riveter simply by changing the dies.

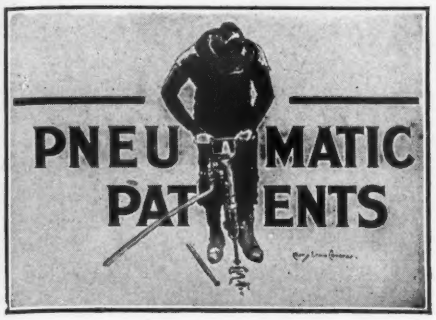
Among the many advantages of this machine is the fact that although it is a stationary unit, it can be readily moved from place to place in the plant where the work is located as it weighs only 600 lbs. complete.

It has a capacity for punching five-eighth inch plate and for riveting three-eighth inch cold rivets and because of this dual use is particularly adaptable for light structural steel fabrication.

The pressure exerted on the punch and rivet dies is approximately 70,000 lbs. It operates on the standard air line pressure of 100 lbs.



Pneumatic punch and riveter.



FEBRUARY 1

1,366,998. VACUUM-SWEEPER. Wilmer H. Yerkes, Pittsburgh, Pa.
1,367,001. PNEUMATIC RAMMER. Thomas P. Anthony, Edgewater Park, N. J.
1,367,079. MOLDING-MACHINE. William H. Nicholls, Brooklyn, N. Y.
1,367,163. PNEUMATIC - DESPATCH - TUBE APPARATUS. James G. Maclaren, Mamaroneck, N. Y.
1,367,201. GAS AND AIR MIXER. Charles Niedergang, Ferdinand Philip Stenger, and Theodore John Frey, Cincinnati, Ohio.
1,367,256. ROTARY FLUID COMPRESSOR, EXHAUSTER, MOVER, OR ENGINE. William G. Hay, Manchester, Lancaster, England.
1,367,259. CAN-FILLING MACHINE. Maurice Hofheimer, Baltimore, Md.
1,367,263. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Charles V. Jameson, Chicago, Ill.
1,367,331. CONTROLLING MECHANISM FOR PNEUMATIC SHEET-FEEDERS. John Tauscher, Philadelphia, Pa.
1,367,332. PROCESS OF AND APPARATUS FOR SEPARATING ORE MATERIALS FROM EACH OTHER. Robert Safford Towne, New York, N. Y., and Frederick B. Flinn, Orange, N. J.
1,367,398. LOIN-HOLDER AND THE LIKE. George R. Keene, Chicago, Ill.

2. In a machine of the class described, the combination of a vertical double acting pneumatic cylinder, a plunger vertically movable therein, a piston rod connected to said plunger, a horizontal arm connected to the upper end of the piston rod, air ports adjacent to the upper and lower ends of the cylinder, a third air port below the upper end of the cylinder, connections to all of said ports, a check valve in the uppermost connection permitting the flow of air into the cylinder while preventing the discharge of air therefrom, and a valve for controlling the flow of air to and from the various connections, substantially as described.

FEBRUARY 8

1,367,554. VACUUM-PUMP. Meredith Leitch, Poughkeepsie, N. Y.
1,367,556. VACUUM-PRODUCING DEVICE. James McAlear, Chicago, Ill.
1,367,560. LUBRICATING DEVICE FOR AIR-COMPRESSORS. John E. Osmer, Owosso, Mich.
1,367,570. THROTTLE-VALVE FOR PNEUMATIC-TOOL HANDLES. Lewis Sykes, Camden, N. J.
1,367,623. AIR-CLEANER. Mathew B. Morgan, Cleveland Heights, Ohio.
1,367,635-6-7. AIR-SEPARATOR. Thomas J. Sturtevant, Wellesley, Mass.
1,367,668. VEHICLE SHOCK-ABSORBING DEVICE. William D. Paxton, Laporte, Ind.
1,367,701. HUMIDIFIER. John I. Haynes, St. Louis, Mo.

5. A humidifier, comprising a casing through which air circulates, means for supplying moisture to the air that flows through said casing, and an adjustable member on said casing provided with an opening for receiving the intake portion of a fan housing.

1,367,704. GAS-BURNER. Ithamar M. Justice, Dayton, Ohio.

11. In a gas burner, a gas nozzle, and an air nozzle outside thereof formed integrally with the burner, means for introducing air to said air nozzle, and a partition dividing the space between the nozzles into two parts, said portion being so arranged that the air admitted will be equally divided between said parts, and an inwardly inclined end of the air nozzle whereby air discharged therethrough will be caused to intersect the discharge from the gas nozzle and to converge at a point opposite the discharge aperture thereof.

1,367,748. AUTOMATIC VALVE-CONTROLLING MECHANISM. Jesse T. Knoles, Winnemucca, Nev.
1,367,864. PRESSURE-CONTROLLING VALVE. Thomas Clarkson, Chelmsford, England.
1,367,865. METHOD OF AND APPARATUS FOR PRODUCING HIGH VACUUM. William W. Cra ford, Philadelphia, Pa.

1. The method of producing a high vacuum which consists in generating an actuating vapor, delivering said vapor by expansion in a free jet in which the vapor is expanded to such a degree that the velocity of the jet is so high in comparison with the relative velocities of the molecules therein that an approximately parallel molecular flow of vapor is produced in the jet, and admitting elastic fluid from the space to be exhausted into said jet.

1,368,001. PUMP. Edward N. Trump and Frank Friedrichs, Syracuse, N. Y.

1. The method of pumping which consists in reciprocating a tube having a suitable foot-valve, by means of a primary medium having high initial and subsequent expansive force utilizing the inertia of the moving parts to store energy and applying said stored energy to the removal of burnt products.

1,368,139. MOTOR-DRIVEN TIRE-PUMP. Gordon N. Guthrey, Dallas, Tex.

FEBRUARY 15

1,368,238. COOLING MEANS FOR COMPRESSORS AND PUMPS. Allan O. Carpenter, Corning, N. Y.
1,368,254. RESUSCITATOR. Albert N. Habberley, Melrose, Mass.
1,371,204. AIR-ENGINE FOR FLYING-MACHINES. Clarence Ernest Holt, Henryetta, Okla.
1,368,365. HUMIDIFIER. Lawrence Adkinson Smith, Fort Gibson, Miss.
1,368,429. SHOCK-ABSORBER. John P. Georgen and Jacob G. Ruesch, Milwaukee, Wis.
1,368,434. FLUID-PRESSURE CLUTCH. Arthur O. Higinbotham, Worcester, Mass.
1,368,470. HAMMER-DRILL. William T. Ayer, Dover, N. J.
1,368,528. AUTOMATIC FLUID - PRESSURE DISPLACEMENT-PUMP. Charles B. Pendleton, Denver, Colo.
1,368,560. OZONE - GENERATOR. Edward Lionel Joseph, Westminster, London, England.
1,368,563. AIR-SPRING SUSPENSION. Richard Liebau, New Haven, Conn.
1,368,598. COMPRESSOR. August P. Anderson, Chicago, Ill.
1,368,752. BURNISHING - MACHINE. Edwin S. Rauworth, South Haven, Mich.
1,368,871. AIR-VALVE. Oscar H. Wisenant, Colorado Springs, Colo.
1,368,877. VACUUM - JACKETED METAL VESSEL. Ewart Sigmund Andrews, Beckenham, England.
1,368,993. MOLDING - MACHINE. Howard Pearson Booth, Montreal, Quebec, Canada.

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1,369,130. FLOOR-CLEANING MACHINE. William A. Rowe, Eau Claire, Wis.
1,369,343. AIR-VALVE. Paul A. Lamb, Yates Center, Kans.
1,369,398. EJECTOR OR INJECTOR. Ernest O. Cartwright, Springfield, Ohio.
1,369,507. DEVICE FOR REGULATING THE TEMPERATURE OF INK-ROLLERS. Wallace S. Warnock, Chicago, Ill.
1,369,520. METHOD OF COATING AND TOOL OR APPLIANCE FOR APPLYING COATING. Herbert W. Day, Wollaston, Mass.
1,369,558. AIR-DELIVERY COOLER FOR TURBO-COMPRESSORS. Earl H. Sherbondy, Cleveland, Ohio.
1,369,568. PRESSURE OR VOLUME RECORDING METER. Charles H. Smoot, South Orange, N. J.
1,369,596. WIND-MOTOR FOR AIR-PUMPS. George Yanacopoulos, New York, N. Y.
1,369,605. SUCTION-BURNER. George Bellon, Vincennes, France.
1,369,618. MOTOR-COMPRESSOR. Niels A. Christensen, Milwaukee, Wis.
1,369,648. PNEUMATIC CONVEYING MECHANISM. George A. Gieseler, Cleveland, Ohio.

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1,369,769. PRESSING - MACHINE. William Edward Andree, Chicago, Ill.
1,369,775. DEVICE FOR HUMIDIFYING THE ATMOSPHERE OF A ROOM. Amos R. Bliss, Chicago, Ill.
1,369,812. APPARATUS FOR COOLING AIR. Garfield L. Hooper, Topeka, Kan.
1,369,935. HOT-AIR SYRINGE. Oscar H. Pieper and Alphonse F. Pieper, Rochester, N. Y.
1,370,254. AIR-COMPRESSOR. Eugene W. Yearsley, Brooklyn, N. Y.
1,370,295. PROCESS OF AND APPARATUS FOR OBTAINING OXIDS OF NITROGEN FROM ATMOSPHERIC AIR. Francis I. Du Pont, Wilmington, Del.
1,370,305. AIR - COMPRESSOR. Edwin A. Golle, Grand Beach, Mich.
1,370,450. VACUUM FUEL-FEED TANK CONSTRUCTION. Webb Jay, Chicago, Ill.

Mr. Carl A. Wendell for several years connected with the United States Steel Corporation, and for the past few years chief engineer of the Amercian Ore Reclamation Co., New York, has been retained by the General Briquetting Co. as consulting engineer.

Mr. Elliot N. Smith, for several years on the engineering staff of the Catskill aqueduct, Board of Water Supply of New York, died recently. After graduating from college he entered the service of the New York Rapid Commission, and later became assistant engineer, Board of Water Supply, New York. After leaving the Board he became associated with the firm of Smith, Hauser & McIsaac, contractors of New York City, and later was appointed supervisor of the bureau of engineering, Nutley, N. J.

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Mr. Michael J. Bolten, Newark, N. J., died reecntly at his home in that city. He was president and treasurer of Couse & Bolten, Inc., Newark, manufacturer's of mechanical belting. He was born in Bridgeport, Conn., was 47 years of age, and has lived in Newark since he was a young man.

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Mr. John F. Layng, formerly connected with the railway and traction engineering department of the General Electric Co., has gone into the consulting engineering field as a partner in the firm of Hemphill & Wells, of New York City.

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Mr. O. W. Sanderson, formerly with the B. F. Goodrich Co., Akron, Ohio, has become secretary and treasurer of the Empire State Engine Corporation, New York.

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Mr. Alfred J. Cleary has resigned as chief assistant engineer of San Francisco to enter private practice as consulting engineer. Mr. Cleary has been employed in the city engineering department for twelve years, and had charge of the work of the Hetch Hetchy project during its construction.

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Mr. F. M. Thebo and Mr. R. C. Starr, construction engineers, have organized the firm of Thebo and Starr, San Francisco, and will undertake design and construction work generally. Mr. Starr will retain his present position in charge of design and construction with the San Joaquin Light & Power Corporation.

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John J. Main, of Toronto, Ont., president of the Canadian Incinerator Co., and a director of the Dominion Radiator Co., died recently at the age of 70. He was the inventor of the Heine boiler and was responsible for many important developments in connection with foundry work. He emigrated from the Island of Jersey to Canada when young, engaged himself as a boiler worker, and as a result of his invention of the Heine boiler made a connection with the Polson Iron Works of which he became vice president and general manager. He retired some years ago but during the war served on the Imperial Munitions Board.

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